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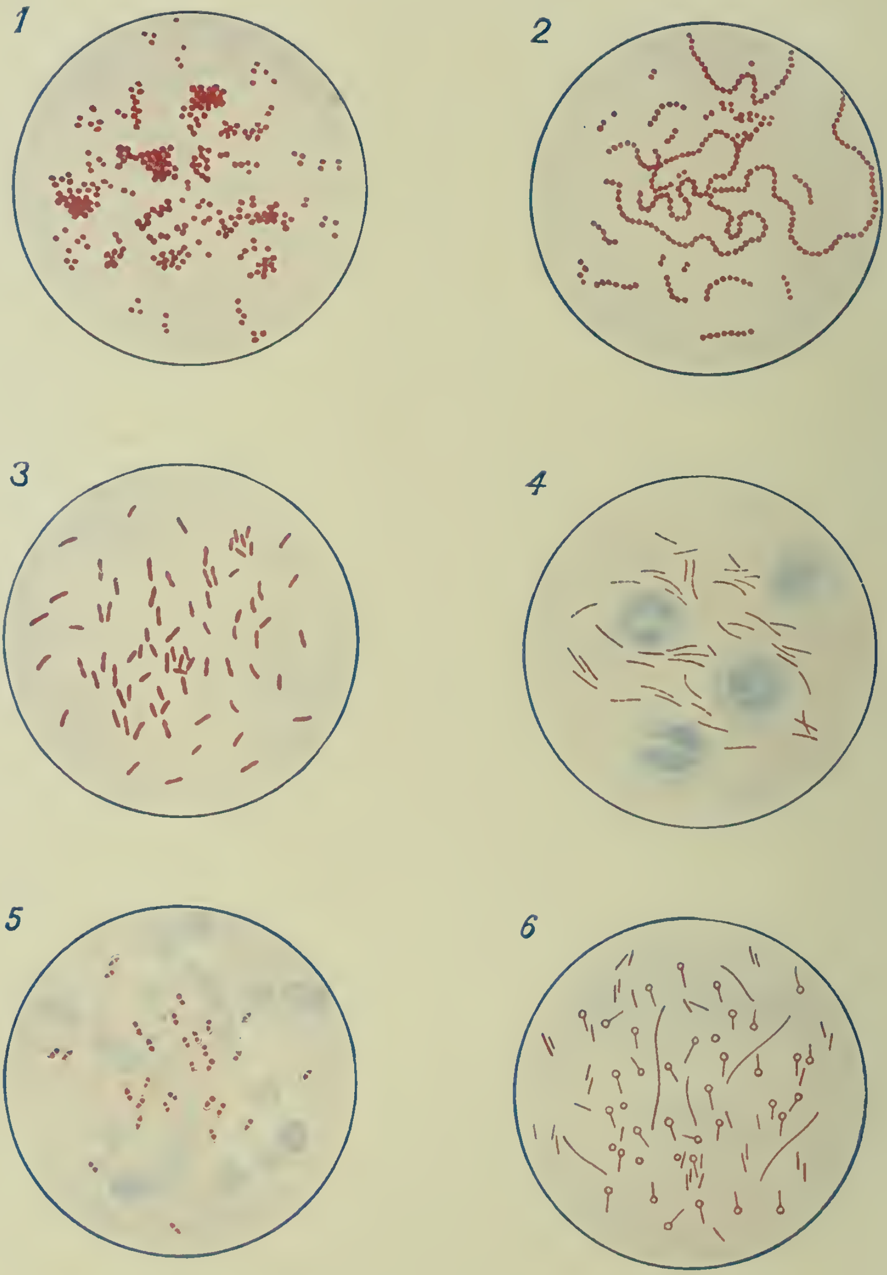
SCIENCE AND ART OF NURSING



PATHOGENIC BACTERIA (*pages 57–59*).

1. STAPHYLOCOCCUS PYOGENES AUREUS. 2. STREPTOCOCCUS PYOGENES. 3. BACILLUS COLI COMMUNIS 4. BACILLUS TUBERCULOSIS. 5. DIPLOCOCCUS PNEUMONIÆ 6 BACILLUS TETANI.

CASSELL'S
SCIENCE AND ART OF NURSING

A GUIDE TO THE VARIOUS BRANCHES OF NURSING, THEORETICAL AND PRACTICAL

BY

MEDICAL AND NURSING AUTHORITIES

ILLUSTRATED WITH COLOURED AND BLACK-AND-WHITE PLATES AND FIGURES IN THE TEXT

IN FOUR VOLUMES

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PHYSICIAN TO THE CHARING CROSS HOSPITAL

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CHAPTER XIII

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By Wm. Cecil Bosanquet, M.A., M.D.(Oxon.), F.R.C.P.

Respiration—The Blood and the Circulation—The Internal Secretions—Muscle—The Nervous System—Reproduction.

IV.—RESPIRATION

By **respiration** is usually meant the action of drawing air into the chest and expelling it again ; but it is necessary to bear in mind that this is only one part of the process, and that we have to consider the absorption of the oxygen of the air by the blood, and the corresponding expulsion of carbonic acid, and also the process by which the absorbed oxygen is taken up by the living cells, and the carbonic acid formed by them as a waste product is given off. Very little, however, is known of this last part of the process.

The action of the chest in drawing in air and expelling it again is exactly similar to that of a pair of bellows ; by alteration in the position of the ribs and diaphragm the cavity of the thorax is enlarged, and air is sucked in ; then by contraction of the chest it is driven out again. The only differences between the action of the chest and that of a bellows are that in the former the air enters and is driven out again by the same tube, the trachea, whereas in the bellows there is a separate orifice for intake of air ; and that in the chest the diaphragm which forms the bottom of the thorax is muscular and contracts, while the soft part of the bellows has no such action.

The ribs which form the walls of the chest may be regarded as a series of hoops working up and down on hinges placed upon the vertebral column. As these hoops are raised upwards, the space inside the chest is enlarged; as they fall again, it is diminished. The raising of the ribs in ordinary breathing is done by the **intercostal muscles**, which occupy the spaces between adjacent ribs. When they contract, they pull the ribs together; and as the first rib is practically fixed, they cause a lifting of the lower ribs towards this point of support. When they cease to contract, the ribs fall again by the action of gravity and by the elasticity of the rib-cartilages, so that the chest returns to its former size.

At the same time that the intercostal muscles contract, the **diaphragm** descends: the cavity of the thorax is thus enlarged from above downwards. The shape of the diaphragm may be roughly compared with that of an umbrella, the central portion being formed of tendon, the sides of muscle. As these lateral muscles contract, they pull down the centre of the diaphragm and render it flatter. As the diaphragm descends, it pushes before it the abdominal organs with which it is in contact, especially the liver and the spleen.

In the recumbent position the abdominal viscera cause some pressure upon the diaphragm, and some force is needed to overcome this pressure. Consequently, when a person has difficulty in breathing, an upright attitude is generally assumed (orthopnœa; *orthos*, upright), in order to relieve the diaphragm by letting the contents of the abdomen fall away from it, so that the pressure is removed.

It is usually stated that men breathe chiefly with the diaphragm, women with the ribs; and certainly the movement of the upper ribs is more conspicuous in women. But the difference in the clothes which they respectively wear must be borne in mind, as the action of stays in compressing the lower ribs and upper abdomen renders more forcible action of the upper part of the chest necessary.

Ordinary quiet breathing is, then, carried on, as has been described, by the action of the intercostal muscles and of the diaphragm. When, however, there is any need for more vigorous respiration, as during exertion, or in the presence of some obstruction in the air-passages, other muscles are brought into play. Any muscle which is attached to the ribs may aid in moving them, if its other point of attachment is fixed. Hence, asthmatic patients often take hold with their hands of some fixed object, such as the back of a chair, so as to render the arms immovable, and thus enable the **pectoral muscles** and the **serratus magnus** and **latissimus dorsi** to aid in moving the ribs; at the same time the **muscles of the front of the abdomen** are used to compress the diaphragm in expiration, and thus expel air actively from the chest. The **sterno-mastoid muscles** may also be brought into play by fixing the head, their contraction then tending to raise the upper ribs.

The air as it enters and leaves the thorax passes first through the **nose,** and is warmed and moistened as it passes over the nasal mucous membrane. Particles of dust and infective germs contained in the air are to some extent filtered off by the hairs in the orifices of the nostrils. In persons who, owing to some obstruction, are unable to breathe through the nose, the air passing through the mouth is not filtered or warmed properly, and disease may result, while the mouth is rendered dry and uncomfortable.

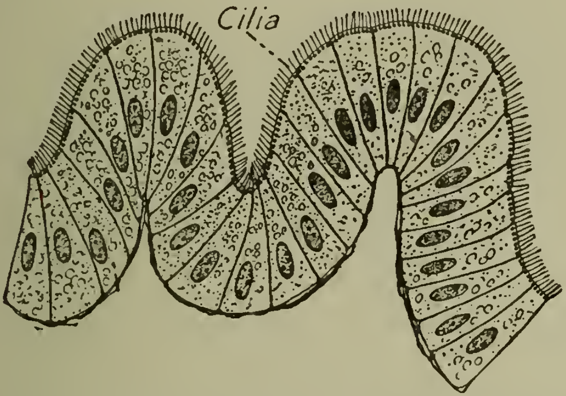

Fig. 27.—Ciliated Epithelium from a Small Bronchus.

The mucous membrane of the nose and of the larynx and bronchial tubes is lined by special epithelial cells, which bear on their surface minute hair-like processes called **cilia** (Lat. = eyelashes). These cilia (Fig. 27) are in constant motion, bending down and rising up again. The movement may be compared with that of the fingers, if these are first extended upwards, then bent down into the palm of the hand, and then extended upwards again. Thus the movement of the cilia is always in the same direction—they do not merely wave to and fro—and the effect of the continual movement of thousands of these little processes is to carry any small particles which lie on the surface of the mucous membrane along in the direction of the movement. This is always towards the outside, so that the foreign matter tends by their action to be expelled.

From the naso-pharynx the air passes through the glottis or opening of the larynx into the **trachea**, and so down into the **bronchi**: these keep dividing and subdividing into smaller and smaller tubes, until we reach the minutest tubules of all, which are only visible with the microscope. These open into the air-cells or **alveoli** of the lungs (Fig. 28). If we were to imagine a bunch of grapes, of which the stalk was hollow, and the grapes formed hollow bags opening directly into the tube of the stalk, we should have a rough idea of the way in which the finest tubules of the lungs open out into the air-sacs. The walls of the alveoli are infinitely thin, and they are surrounded by a network of minute capillary blood-vessels, so that the air in the alveoli is brought into close contact with the blood. Through the thin membrane the oxygen of the air is taken up by the blood, and the carbonic acid which exists in the latter is given off into the air-cells and eliminated by the lungs. It has been estimated that if all the air-cells of the lungs were cut open and spread out flat, the area covered would be over 200 square yards; while a film of blood not much thicker than a single corpuscle is spread out over them. The opportunity for the exchange of gases is thus very great.

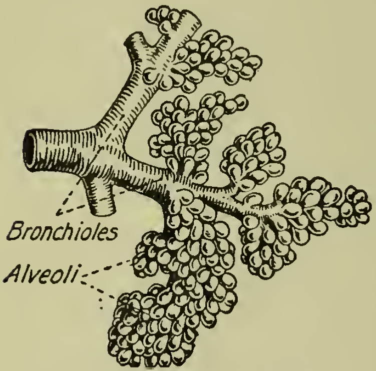

Fig. 28.—Alveoli of Lung.

In ordinary quiet breathing the movement of the chest is not very great, and the quantity of air which is drawn in and expelled again at each breath, called the tidal air (Fig. 29), is about 30 cubic inches, or rather more than the contents of a cubical box each side of which is 3 inches. By vigorous inspiratory efforts it is possible to draw into the thorax about four times as much as this in addition (complemental air), or a total of 150 cubic inches more than is present in the lungs at the end of a quiet expiration.

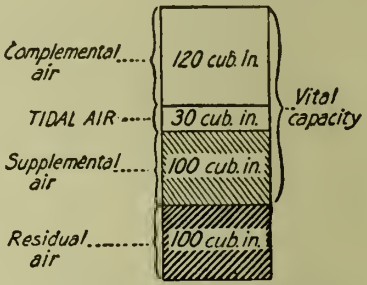

Fig. 29.—Diagram of Complemental, Tidal, Supplemental and Residual Air.

On the other hand, by strong expiration it is possible to expel from the chest about 100 cubic inches of air which are normally left in the chest at the end of a quiet expiration (supplemental air). Even this does not entirely empty the lungs of air, for after the most violent possible effort of expiration there will remain in the lungs about 100 cubic inches of air which it is impossible to get rid of by any voluntary effort.

If we add these quantities together, it appears that the total amount of air which the lungs are capable of containing at any one time is about 350 cubic inches.

The amount of air which can be drawn into the chest by the most vigorous possible inspiration following the most forcible expiration, or which, conversely, can be expelled from the chest by the most forcible possible expiration after the most vigorous possible inspiration, is sometimes called the "vital capacity." It differs, of course, in different individuals, according to the size of the chest and the vigour of expansion; but on an average it may be taken as 250 cubic inches.

Now, since in respiration oxygen is absorbed from the air, and carbonic acid is given off into the air-cells, the expired air must contain less oxygen and more carbonic acid than the inspired air. It also contains more water, owing to which it is that on a cold day the breath appears as a visible cloud, and that drops of water condense from it when a cold surface is breathed upon. In addition to the carbonic acid and water which it contains, expired air is contaminated with some volatile animal matter which renders air that has passed through the lungs unwholesome for further respiration, even if it be diluted with so much fresh air as to render the actual excess of carbonic acid and defect of oxygen unimportant. The nature of these products has not been identified, but the "stuffy" sensation produced by a room in which many persons have been shut up together without ventilation is sufficiently well known.

Ordinary air consists, roughly speaking, of four parts of **nitrogen** to one of **oxygen,** along with which are traces of carbonic acid and of watery vapour. The air is of a certain density; that is to say, a cubic foot of air at the earth's surface always contains approximately the same quantity of oxygen and nitrogen. If, however, we ascend far above the sea level (from which heights are calculated), as, for instance, up a very high mountain or in a balloon, the air becomes rarefied, *i.e.* there is less air, and so less oxygen, in every cubic foot. Difficulty in breathing then arises, as the lungs draw in so much less oxygen at each inspiration that the blood becomes starved of oxygen.

Nitrogen is not in itself of any importance in respiration, but it serves to dilute the oxygen, which cannot be breathed pure for any length of time without producing disagreeable effects.

A consideration of the amount of carbonic acid given off by the lungs is of importance as a guide to the amount of air needed for proper ventilation of rooms. In expired air about 1 part in 25 is carbonic acid; and as a man exhales some 30 cubic inches every breath, breathing about 15 times to the minute, the quantity of carbonic acid exhaled in one hour will be $\frac{30 \times 15 \times 60}{25} = 1{,}080$ cubic inches. Now, a room is "stuffy" when the carbonic acid in it amounts to more than 1 part in 5,000. In order, therefore, to keep the amount of carbonic acid down to this limit, the 1,080 cubic inches must be diluted at least 5,000 times. Each person consequently needs a supply of (1,080 × 5,000) 5,400,000 cubic inches of air, or rather over 3,000 cubic feet, per hour. In other words, a man sitting in a room about 15 feet square and 15 feet high will need a complete change of the air in the room once in every hour; and if two people occupy the room the air must be changed twice as often.

The provision of means for introducing fresh air at the required rate constitutes the problem of ventilation, difficulties arising from the necessity of preventing unpleasant draughts, and in winter of maintaining the temperature of the room at a tolerable level.

The ordinary **rate of respiration** has been taken, in the foregoing calculation, as 15 to the minute; actually it varies in different persons, and in the same person at different times. Anything between 12 and 20 respirations to the minute may be considered normal. The frequency of respiration is enhanced by muscular exertion, since the effect of work is to increase the output of carbonic acid and to necessitate a more plentiful supply of oxygen. In fever also the respiration-rate is increased, and in all conditions in which there is defect in the quality of the air breathed or in the entry of air into the chest. A similar effect is produced by defective circulation of blood through the lungs, as in this case the blood-corpuscles are not brought round with sufficient frequency to take up the oxygen needed. In all these conditions—bad air, insufficient entry, failing heart—there is dyspnœa, or difficulty in breathing.

If air is prevented from entering the chest, **asphyxia** results ; the word means literally "pulselessness," but it is reserved for the condition of insensibility which results from suffocation. If the trachea in an animal is suddenly blocked, violent inspiratory efforts first occur, the heart beats more and more frequently, and the tongue and lips become purplish-red or blue. Then general convulsions occur (second stage), and finally movements cease, the pupils dilate, the pulse stops, and death occurs. After death there is found great distension of the right side of the heart with blood. Even after the heart has stopped, recovery may ensue, if appropriate measures are adopted for forcing air into and out of the chest—artificial respiration. Opening a vein so as to relieve the distended right heart facilitates restoration.

Difficulty of breathing (*dyspnœa; dys*, difficult, *pnœa*, breathing) may result either from absence of sufficient oxygen or from the presence of excess of carbonic acid in the air breathed. Thus, if one breathes pure oxygen from a closed bag, into which one also expires, dyspnœa occurs before the proportion of oxygen is reduced to that of the ordinary air, because there is excess of carbonic acid in the bag along with the oxygen. On the other hand, on making an attempt to breathe pure nitrogen or hydrogen—non-poisonous gases, but containing no oxygen—suffocation rapidly ensues.

If, on the contrary, a few breaths of pure oxygen are taken, or a number of very deep inspirations of ordinary air, more than the usual amount of oxygen is taken up in a short space of time, and a person may then remain for some seconds without making any effort to breathe, and may be found to begin breathing again with very slight movements of the chest, the additional supply of oxygen previously absorbed being sufficient to keep the vital processes going normally during the pause, which is known as a condition of *apnœa*.

The rate and depth of respiration are regulated by the **nervous system**, by means of the nerves which supply the diaphragm and the intercostal muscles. These nerves are derived from a point in the upper part of the spinal cord, and to this point converge a number of sensory nerves which bring messages from different parts of the body. Thus the respiration may be affected by a sudden dash of cold water on the skin, or by a voluntary impulse from the brain, or in many other ways. But the most important agent in regulating the respiration, by its action on the nervous centre, is the **blood**. If this contain too much carbonic acid it at once stimulates the centre to quicken the rate of breathing, so as to eliminate the poison from the blood; while if there be excess of oxygen present in the blood, as in apnœa, the rate of respiration is slackened or the whole process momentarily stopped.

Interchange of gases.—We have spoken so far of the entry of air into the lungs, and its expulsion from them again. The next step in the process of absorption of oxygen is the taking up of this gas by the blood and the expulsion of carbonic acid into the alveoli.

The agent for the absorption of oxygen is the colouring matter of the red corpuscles—the hæmoglobin. If some of this substance be prepared and dissolved in water, and the solution be shaken up with some oxygen gas, it is found that the hæmoglobin is able to take up a considerable quantity of the gas; while, on the other hand, if fresh blood be placed in a specially devised air-pump, the oxygen which it contains is given off again and can be measured.

The carbonic acid is not held in the blood in combination with the hæmoglobin, but is dissolved in the fluid part of the blood (plasma). The combination of hæmoglobin with oxygen (oxy-hæmoglobin) is not very firm, and is readily broken up into free oxygen and hæmoglobin; and the living cells, which have a very strong affinity with oxygen, easily take what they need from the blood. Thus, if a frog be killed and one leg cut off (the muscles go on living for some time after the death of the animal), and if blood be made to circulate through the vessels of the severed limb, it is found that the escaping blood is richer in carbonic acid and poorer in oxygen than the entering blood. If the muscle is made to contract by means of an electric current, more carbonic acid is given off and more oxygen consumed. Similarly, if a living excised muscle is placed in a vessel of air, and left there for some time, the air at the end will be found to have lost oxygen and gained carbonic acid. If the muscle be suspended in nitrogen gas instead of air, it is still found to give off carbonic acid, although no oxygen is present; consequently, the carbonic acid must be derived from the breaking down of the muscle-substance, and is not formed directly by the action of oxygen upon the carbon contained in the muscle-protoplasm.

The larynx.—The larynx (Fig. 30) is the arrangement by which sound is produced by expired air, and is situated at the entrance to the trachea. Its orifice is slit-shaped, and is formed by two tightly stretched folds of membrane, the edges of which constitute the *vocal* *cords.* If these folds are brought close together and air is then forced between them, they are set in vibration and sound is produced. The more tightly they are stretched, the higher (shriller) is the pitch of the note produced. The longer the cords themselves, the deeper the note; hence men, who have larger larynxes, have deeper voices than women or children. The larynx produces sound; it does not form letters or words, which are made by movement of the tongue, lips, and palate. If the larynx is diseased, whispering is still possible, but the voice is lost. In such circumstances a mechanical reed (as in an organ) can be substituted for the larynx, and the voice restored, only there will be no possibility of varying the note, and the voice will be monotonous.

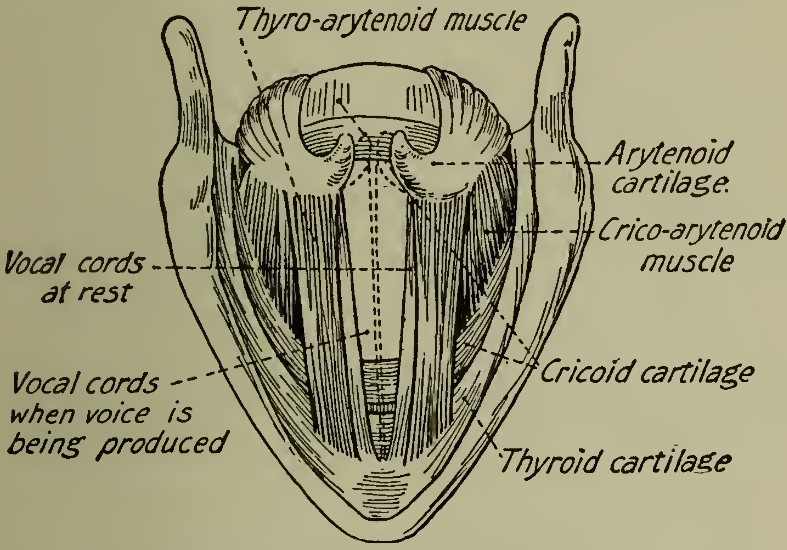

Fig. 30.—The Larynx seen from above.

In breathing, the vocal cords are held apart so as to leave plenty of space for the passage of air. In coughing, the cords are first closed, while a strong expiratory effort is made, and then are separated suddenly, allowing the imprisoned air to escape with a rush, carrying with it any particles of mucus or any foreign bodies which have irritated the air-passages. In speaking, the cords are approximated one to the other, and also tightened and loosened at will so as to vary the tone of the voice. All these movements are rendered possible by the structure of the larynx and the action of the muscles by which it is worked.

The folds of membrane which constitute the vocal cords are attached at their posterior extremities to small cartilages, the *arytenoid cartilages* (Fig. 30). In section these are roughly triangular in shape, and they are fixed by one corner, upon which they can swing round, backwards, and forwards. The vocal cords are attached to the corner which projects forwards and inwards, and as the cartilages swing, the cords are brought either nearer together or farther apart. The swinging motion is brought about by the action of muscles attached to the third corner of the triangle, that projecting outwards on either side, one muscle pulling this corner of the arytenoid cartilage forwards and so bringing the cords nearer together, the other pulling it backwards and separating the cords.

The arytenoid cartilages are set upon the rim of a cartilaginous ring called the *cricoid* (ring-like) *cartilage* (Fig. 30), and the vocal cords run from the corners of the arytenoids forwards, to be attached at their other extremities to the inner surface of another cartilage of the larynx, the *thyroid* (shield-like) *cartilage* (Fig. 30). The latter is joined to the cricoid by a movable joint in such a way that it can move a little, backwards and forwards. By this movement the distance between the top of the cricoid cartilage and the inside of the thyroid is either increased or diminished, and the vocal cords are thus rendered tenser or looser. The pitch of the voice is thus regulated.

The movement of the two cartilages just mentioned is produced by the contraction and relaxation of the muscle which runs between them, the crico-thyroid muscle.

Other muscle-fibres run in the substance of the vocal cords themselves, and are supposed to bring about tightening and apposition of parts of the cords, not of the whole ; and the so-called " falsetto " notes are said to be produced in this way.

The muscles of the larynx, with the exception of the crico-thyroid, are supplied by the recurrent branch of the vagus (10th) nerve, which is given off from the main trunk of the nerve within the thorax. The opening of the larynx—called the *glottis*—is very sensitive, and if any particle of food or any foreign body enter it, a spasm of cough is at once excited, and the offending matter is thereby expelled. If sensibility is lost, and cough therefore fails to ensue, particles of food may enter the lungs and set up dangerous inflammation.

The larynx is attached above to the hyoid bone at the base of the tongue, and as this is drawn up in the process of swallowing, the larynx also rises—as may be felt by placing the finger on the prominent part of the thyroid cartilage (" Adam's apple ") while swallowing. By this movement the larynx is drawn beneath the epiglottis and base of the tongue as food passes down the throat, and the opening is thus protected against entrance of food or drink.

V.—THE BLOOD AND THE CIRCULATION

THE BLOOD

The blood is the fluid medium by which food and oxygen are carried to all the cells of the body, and into which the waste products of these cells are cast and carried away for excretion. In order that these duties may be properly carried out it is necessary that the blood should be propelled continually in a circle, so that fresh parts of it are constantly brought into contact with the lungs and digestive apparatus, by which supplies of air and food are introduced, with the living cells to which it ministers, and with the skin and kidneys, which eliminate waste.

The circulation of the blood, discovered by William Harvey in the year 1628, is maintained by the pumping action of the heart, which forces the blood through the arteries and veins; these constitute a system of closed tubes, from which the blood as such does not pass out, but through the walls of which an interchange of material can take place. Some fluid is, however, constantly exuding from the blood into the tissues round, constituting the lymph which actually bathes the cells, and which is gathered up by special vessels, and returned into the blood-stream after it has done its duty as middleman between the blood and the cells.

Composition of blood.—If a drop of blood be put on a slide under the microscope it will be seen to consist of a colourless fluid in which are suspended a large number of small floating bodies, the *corpuscles* (Fig. 31). These are of two kinds; the great majority are round disc-shaped bodies, which appear of a pale-yellow colour when they lie flat on the field of the microscope. When they are massed together they give to the blood the familiar bright-red hue. These *red corpuscles* look rather darker at the edge than in the centre, owing to their being slightly thinner in the middle. They tend to run together into rolls or rouleaux, like coins placed one upon the other. There are approximately 5,000,000 red corpuscles in a space of 1 cubic millimetre, that is, in a space equal to a cube each side of which is $\frac{1}{25}$ of an inch, or about equal to the size of a large pin's head.

If a mounted specimen of blood be allowed to remain for some time under the microscope, so that the liquid part of the blood tends to dry up, the red corpuscles shrivel and assume a prickly appearance. If, on the other hand, a drop of distilled water be added to the blood, so as to dilute it the corpuscles swell up and burst. It is thus shown that each corpuscle is enclosed in a thin membrane. In the frog and other cold-blooded animals, and in birds, the corpuscles are oval in shape and contain a nucleus; in the camel they are round and nucleated; in man and other mammals they are round and have no nuclei.

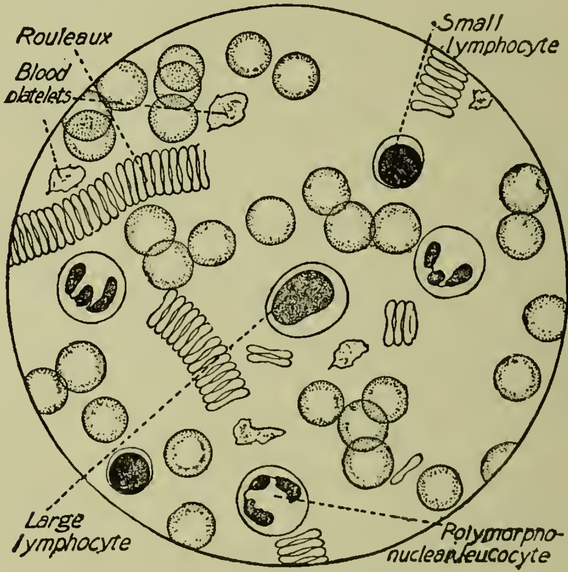

Fig. 31.—Blood Corpuscles.

The other variety of corpuscles of the blood consists of the *white corpuscles* or *leucocytes* (*leucos*, white; *cytos*, a cell). These are colourless bodies, consisting of a nucleus surrounded by a little mass of protoplasm. They resemble the amœba described in the introductory section (Vol. I., p. 230), that is, they are capable of movement of a crawling character, and have the property of surrounding any small foreign bodies which they may encounter, just as the amœba engulfs particles of food. An example of this property is seen in the case of leucocytes present in the neighbourhood of an extravasation of blood ; they are found loaded with small particles of pigment derived from broken-up blood-corpuscles which they have swallowed.

Another example, and one more important, is their action upon the bacteria which produce disease ; these the leucocytes engulf, and perhaps kill, thus affording protection to the body against the attack of these invaders. It is also probable that the white corpuscles contain within them substances which are poisonous to bacteria, and that they can take part in the destruction of such germs without actually swallowing them. The leucocytes are thus at once the scavengers and the police force of the body, removing refuse and imprisoning evil-doers.

There are several different kinds of white corpuscles, some having a large single nucleus (lymphocytes), others a small one, others again a nucleus which is divided into several pieces united by slender threads. These last, the so-called polymorphonuclear cells, are the most important variety, and form by far the largest number of all the white corpuscles.

In number the leucocytes form about 1 in 500 of all the corpuscles, there being about 10,000 of them in a cubic millimetre. The number varies from time to time, more leucocytes appearing in the blood after a meal. It has been suggested that they act as the carriers of certain food-stuffs from the intestine to the tissues.

Besides the red and white corpuscles, there are also found in the blood minute round bodies called *blood platelets*. They are very much smaller than the corpuscles, and their exact nature and use are doubtful. Apparently they take part in the process of coagulation of the blood.

The chief source from which the corpuscles of the blood are derived is the red marrow of the bones. The red corpuscles are formed here by large cells, which expel them into the blood. Some of the white corpuscles also arise in the marrow, especially those which possess divided nuclei, and possibly some of the large cells with single nuclei. Lymphocytes are formed in the lymphatic glands, and perhaps also in the spleen.

Owing to their power of movement the leucocytes can pass through the walls of the smallest blood-vessels, and wander out into the surrounding tissues ; they may then return again to the blood-stream. They are attracted out from the vessels by the presence of certain chemical substances, especially by some which are formed by bacteria ; leucocytes thus tend to accumulate at any point at which germs are situated. Pus consists of dead leucocytes accumulated in this way.

Chemical composition of blood.—In 100 parts of blood there are about 80 parts of water and 20 parts of solid matter. Of the latter, some is dissolved in the fluid portion of the blood—the plasma—and the rest forms the corpuscles. By spinning the fresh blood rapidly in a centrifugal machine the corpuscles may be separated from the plasma, and each portion can be examined separately. Any volume of blood contains about two parts by weight of plasma to one of corpuscles, and the plasma consists of one part of solid material dissolved in ten parts of water.

The solid matter is chiefly albuminous material, consisting of two substances called respectively serum-albumin and serum-globulin, with a small amount of common salt (sodium chloride) and minute quantities of phosphates, carbonates, fat, sugar, and urea. With the serum-globulin is included a substance known as fibrinogen, which is of importance in the process of coagulation or clotting of the blood.

The red corpuscles themselves contain a considerable quantity of water, along with the colouring matter, hæmoglobin, and a framework of supporting substance. *Hæmoglobin* (*hæma*, blood ; *globus*, a globe or round body) is a red substance which can be obtained in the form of crystals. It readily combines with oxygen, and its great importance in the living body is its power of taking up oxygen from the air, and then giving it up again to the cells of the tissues. Hæmoglobin, when combined with oxygen (oxy-hæmoglobin), is of a bright-red colour ; when it has given up the oxygen it is much darker, of a purplish colour (reduced hæmoglobin). Arterial blood contains oxy-hæmoglobin, venous blood reduced hæmoglobin, the difference of colour in the two being thus explained. If fresh arterial blood is kept in a stoppered bottle it loses its combined oxygen and becomes " reduced," at the same time darkening in colour. If this dark blood, or blood taken from a vein, be shaken up with air or free oxygen, it becomes bright-red in hue, oxygen being again absorbed.

Hæmoglobin possesses the property of combining with other gases besides oxygen, as with hydrogen sulphide (sulphuretted hydrogen) and carbon monoxide. The latter combination is of some importance.

Carbon monoxide differs from carbonic acid or carbon dioxide (CO_2) in that it contains one particle of carbon combined with only one of oxygen (CO) instead of with two. It is a poisonous gas, often formed in the slow combustion of charcoal, and also contained to some extent in ordinary coal-gas. When a person is exposed to the fumes of a charcoal fire or to escaped gas the hæmoglobin of the blood combines with the carbon monoxide, and fatal poisoning ensues. The combination of hæmoglobin with carbon monoxide is of a bright cherry-red colour, and persons thus poisoned present a peculiar pink colour of the lips and face.

Hæmoglobin differs from most animal substances in that it contains a considerable amount of iron. From hæmoglobin are derived other pigments which occur in the body, namely, the bile-pigments and the colouring matter of the urine. These, however, contain no iron. When blood-corpuscles escape from the vessels into the tissues, as when small vessels are ruptured by injury, the corpuscles break up, and hæmoglobin is set free. In old extravasations, masses of brown or blackish pigment are found, differing from hæmoglobin in not containing iron; to this substance the name of "hæmatoidin" is given. The greenish or yellowish discolouration round a bruise is due to the presence of this substance. The iron of the blood, when set free by the breaking up of hæmoglobin, is taken up by the cells of the liver, and is doubtless used again for the formation of fresh blood-corpuscles.

If blood-corpuscles are shaken up with distilled water they break up, and the hæmoglobin is dissolved by the water. The blood is then said to be "laked."

Clotting of blood.—If freshly-drawn blood is allowed to stand for a short time in a basin, it sets into a red jelly, which is so firm that the vessel can be turned upside down without any of the coagulated blood escaping. This jelly gradually shrinks, a yellow fluid exuding from it, until there remains a mass of red clot floating in a straw-coloured fluid. The fluid is called *serum*. If the solid clot be carefully washed in a stream of water, the red corpuscles are removed, and there is left behind a network of fine fibrils in which they were enclosed. These consist of substance known as *fibrin*, to the formation of which the coagulation of the blood is due. If the freshly-drawn blood is whipped with a bundle of twigs, the fibrin, as it forms, adheres to these as a mass of colourless threads, and the blood-corpuscles remain behind in the serum, which is red in consequence.

It is found that clotting of blood takes place most quickly when it is kept warm, and that it is altogether prevented if the fresh blood is kept at freezing-point. It has also been shown that contact with a rough surface aids clotting; while if blood is run into a vessel the inner surface of which is covered with a layer of oil, coagulation does not readily take place. The inner lining of healthy blood-vessels is quite smooth, and blood can be kept fluid for a long time in a portion of freshly excised vein. On the other hand, if the lining membrane of a vein be injured during life, a clot of blood will form at the injured point even in a living animal. When a wound occurs, the escape of blood is soon prevented by the occurrence of clotting; the value of this property of blood is illustrated by those patients called "bleeders," in whom coagulation is defective, and who may in consequence bleed to death from some trifling injury such as the extraction of a tooth.

If fresh blood is spun in a centrifugal machine, the corpuscles sink to the bottom and the plasma floats on the top. This plasma alone is capable of clotting. By adding to this plasma a certain quantity of magnesium sulphate, it is possible to precipitate the substance, already alluded to, named fibrinogen. This does not clot spontaneously on standing, but if a minute trace of blood be added to it, it at once clots, undergoing transformation into fibrin. From this we learn that for coagulation to take place two separate substances are necessary—fibrinogen and something else. The latter is a body capable of acting in minute quantities; it acts best in the warmth (about body-temperature), not at all at freezing-point; it is destroyed by boiling. These peculiar qualities are those of a special class of substances called "ferments," as they resemble the substance which causes the fermentation of sugar whereby alcohol is produced. The substance which causes the coagulation of the blood is called *fibrin-ferment.* It is probably contained in the blood-platelets already described, being formed from these in the presence of lime-salts which are contained in the blood. If these salts are removed, clotting does not occur.

Certain chemical substances may prevent the occurrence of clotting, such as peptones (digestive products) and the substance contained in the saliva of the leech; the latter seems to neutralise the fibrin-ferment, and thus renders it easier for the leech to extract its fill of blood.

Lymph.—Since the blood is contained within a system of closed tubes, it cannot come directly into contact with the cells of the body.

It is necessary, therefore, to consider how these last obtain their food and oxygen from it. This is done by means of the lymph, a colourless fluid which bathes the cells of the body, filling up the interstices of the tissues. It is formed by exudation of some of the plasma of the blood through the thin walls of the capillary blood-vessels, and thus contains both oxygen and food-material. As the cells take these from the lymph, the latter receives more from the blood, and it at the same time gives to the blood the products of tissue-waste which are shed into it by the cells. The more rapid the flow of blood through any part, the greater is the escape of lymph. But not only must the lymph exude into the tissue spaces, it must also be passed along to make room for more, and must ultimately return to the blood-stream. For this purpose the minute lymph-channels between the cells open into larger vessels, and these again into trunks of considerable size. The flow of lymph through these channels (lymphatics) is maintained by contraction of the surrounding muscles, and by the existence in the lymphatic vessels of valves which only permit the fluid to flow in one direction.

At certain points the lymphatic vessels pass through small nodular masses, known as *lymphatic glands*. These consist of masses of small round cells, like minute leucocytes, between which the lymph-channels run. The use of these glands is to filter off from the lymph any foreign bodies which it contains, and which might do damage if they reached the blood-stream. The most important of such foreign bodies are bacteria; these are arrested in the glands, and are here brought into contact with a great number of leucocytes, which devour or destroy them. In the process inflammation is often set up, and enlargement of the glands results—inflamed glands being commonly seen along the course taken by lymph in passing from an infected wound.

Excessive escape of lymph into a part constitutes *œdema* (Greek, = swelling).

THE CIRCULATION

If the transparent web of a frog's foot be placed under the microscope, it is possible to observe the flow of the blood through the capillary vessels; it takes place always in the same direction, entering the foot through the arteries, passing through the capillaries, and being carried back again by the veins. This continual flow is maintained by the pumping action of the heart.

In some of the lower animals, such as fish, the heart is a simple organ, almost exactly comparable with an ordinary "enema syringe"; it sucks in the blood by one orifice and expels it by another, by means of the contraction of its muscular wall, this contraction being equivalent to the compression of the syringe by the hand outside. The fish's heart differs from the syringe only in having two chambers instead of one, the first chamber or auricle passing the blood on into the second chamber or ventricle, and the latter expelling it into the arteries. The back-flow of blood is prevented in the heart, as in the syringe, by an arrangement of valves which permits of passage only in one direction.

In the human heart the arrangement is more complicated, inasmuch as the heart is double, consisting of a right side and a left, the blood expelled from the left ventricle passing back to the right side of the heart, and that from the right ventricle to the left side of the heart, before it completes its circuit and regains the point from which it started. This arrangement is due to the development, in warm-blooded animals, of the lungs, which demand a special circulation of their own.

If we take a blood-corpuscle and follow its course from the moment when it leaves the left ventricle of the heart and passes into the aorta, we find that it is carried along the arteries, through smaller and smaller vessels, perhaps down to the extremity of the great toe, or to the finger, or to the kidney or some other organ, and finally reaches the network of capillaries into which the smallest arteries break up. Through some part of this meshwork it passes into a small vein, and then it is borne on through veins which grow larger and larger, until it reaches one of the great venæ cavæ which enter the right auricle of the heart. The corpuscle has thus traversed the greater or **systemic circulation**.

Next it passes from the right auricle into the right ventricle, and thence it is expelled into the pulmonary artery, and is carried through some of the capillaries of the lungs, taking up oxygen as it goes; then back again by the pulmonary vein to the left auricle of the heart, and from this to the left ventricle, from which we have traced its course. The path from the right auricle to the left constitutes the lesser or **pulmonary circulation**.

The structure of the **heart** has already been described in the chapter on Anatomy. It remains to describe the changes which take place in it when it is at work.

If the thorax of a living animal be opened while it is under the influence of an anæsthetic, respiration being meanwhile maintained artificially, it is seen that at each beat or *systole* (*systolé*, contraction) a contraction begins in the auricles, which simultaneously expel their contents into the ventricles. The latter then contract, also simultaneously, and empty themselves into the arteries with which they are connected. After this a pause occurs, during which the chambers of the heart are relaxed, and then another contraction—first of the auricles, then of the ventricles—takes place. During the pause of *diastole* (*diastolé*, relaxation) of the heart the blood is running into the auricles from the great veins, and possibly some actually enters the ventricles, as the valves do not prevent passage in this direction. When the auricles contract, the auriculo-ventricular valves remain open and the blood from the auricles is passed on into the ventricles. Then the ventricles contract, and as they do so the flaps of these valves float up and close the openings into the auricles, so that the blood can only escape into the arteries, the semilunar valves at the orifices of these being still open. When the contraction of the ventricles ends and these chambers relax, the semilunar valves fall into place, pressed by the blood in the arteries, and the return of blood into the ventricles is prevented.

If the ear be laid upon the chest-wall over the situation of the heart, a double sound is heard, which has been compared with the sound of the syllables "*lub-dup*." The first sound, of a dull booming character, is caused by the contraction of the ventricles, and is due mainly to the closure of the auriculo-ventricular valves; partly also, perhaps, to the actual contraction of the muscular wall of the heart. The second sound, short and sharp in character, is due to the closure of the semilunar valves of the aorta and pulmonary artery, which are suddenly stretched tight by the pressure of the blood upon them, and give rise to a sound like that produced by a pocket-handkerchief, for example, which is suddenly pulled tight between the hands. The first sound of the heart is most clearly heard at the apex, the second at the base of the heart.

The heart beats—that is to say, the ventricles contract—at the rate of some 70 to 80 times a minute, and the ventricles empty themselves completely or almost completely at each stroke. Now, in order that the circulation may be maintained equably, it is necessary that each ventricle should discharge at each beat exactly the same quantity of blood as its fellow, since otherwise the blood would be unequally distributed, and a break-down would occur. Thus, supposing the right ventricle to discharge into the pulmonary artery a smaller quantity of blood than the left ventricle throws into the aorta, it would soon be found that the systemic circuit would become engorged with blood, since the right side of the heart would not pass on the blood so rapidly as it was supplied by the left side. On the other hand, if the left ventricle pumped less hard than the right, the lungs would be over-distended with blood.

Probably about four ounces of blood are discharged by each ventricle at a single beat. At this rate, 280 to 320 ounces will pass through the heart every minute. This represents a larger amount of blood than that contained in the whole body, which has been estimated at some 14 lb. or less than 200 fluid ounces.

An attempt has been made to estimate the time necessary for any one portion of blood to traverse the whole circulation, by injecting into a vein some easily-recognisable chemical substance, such as potassium ferrocyanide, and finding how long it takes to return to the same spot. For this purpose a vein is opened between two ligatures, the salt is injected into the end leading to the heart, and the blood that escapes from the other cut end is tested for the salt. In this way it is found that a time of about half a minute suffices for the salt to reappear; but this test is not a fair indication of the average time taken in making a full circuit, since some of the blood goes round by a much shorter path than other portions. For example, a blood-corpuscle which enters the renal artery and passes through the kidney, and back by the renal vein into the vena cava inferior, travels a much shorter road than one that has to go round by the great toe. The experiment with the salt only shows the time necessary for any portion of blood to travel the shortest circuit between the two points, not the average time of all the blood.

The arteries.—At each beat of the left ventricle a quantity of blood is forced into the aorta, and prevented from flowing back by the semilunar valves. Now, if the blood could escape from the aorta as quickly and easily as it entered, it would not exert any pressure on the walls of the vessel. But owing to the breaking up of the arteries into smaller and smaller tubes, and the final ending of these in the minute capillaries, through which the blood only passes with difficulty, a resistance is offered to the flow of blood. Consequently, as each new charge of blood is forced into the aorta, it distends this vessel, which is very elastic. Then, when the heart is in diastole, the elastic recoil of the walls of the aorta keeps up the pressure on the blood in it, and maintains a steady flow.

The condition is somewhat similar to that prevailing in some kinds of scent-spray, in which the rubber ball compressed by the hand pumps air first into another elastic ball, which becomes distended with air; from this it is forced out by the elasticity of the second ball, issuing in a steady stream instead of in a series of puffs as it does from the ball held in the hand.

The elasticity of the arteries thus maintains a constant stream of blood between the beats of the heart.

As the arteries remain full between the beats of the heart, a shock is communicated to the whole column of blood which they contain at each contraction of the ventricles, and this shock travels as a wave from the heart to the smallest arteries, the wall of the vessel expanding with the increase of pressure within it. It is perceptible to the finger placed upon any superficial artery, and constitutes the pulse.

If an artery is cut through, as in the course of an operation, the blood escapes in a series of jets corresponding with the beats of the heart; but even between the jets it escapes under considerable pressure, owing to the elastic tension of the arteries, so that it may be compared with a fountain which always reaches a certain height, but spurts up more vigorously at intervals.

The **pulse** may be most conveniently felt in the radial artery at the wrist, but other superficial arteries, such as the posterior tibial behind the inner ankle-bone, the temporal artery, the facial, and many others, are also perceptible. The *frequency* of the beat, being that of the heart, is from 70 to 80 a minute, but much variety may be observed. Thus in children the pulse is more frequent ("quicker"), gradually falling as they grow older from 100 or so to the normal adult level about puberty. In old age the pulse is usually less frequent.

Attitude affects the frequency of the pulse, which is greater in standing than in sitting, and in sitting than in lying down, owing to the increased muscular effort involved in maintaining the erect posture. After meals the pulse beats more rapidly, and exertion of any kind produces the same result. Fear, anger, and other emotions also quicken the beat, as do alcohol and many stimulating drugs. Digitalis, on the other hand, tends to render the heart's action slower, but also more forcible.

The beats of the heart follow each other at *regular* intervals, any irregularity of rhythm being, as a rule, the result of disease. In some persons the heart tends to drop a beat occasionally throughout life ("intermittent pulse") without any other signs of disorder being discoverable.

It is possible to recognise with the finger that the *size* of the radial artery varies from time to time. This is due to the contraction and relaxation of the muscular coat of the vessel. The *tension* or pressure of the blood within the artery can also be gauged to some extent. This pressure depends on the force of the heart's action on the one hand, and on the resistance to the flow of blood through the capillaries and minute arteries on the other. When the tension is low, the vessel cannot be felt between the beats of the pulse ; when it is high, the artery feels like a cord under the finger during diastole as well as systole of the heart.

If, instead of the finger, a light lever be made to rest upon the artery, it is possible to obtain a tracing of the exact movements of the vessel-wall. Such a tracing is called a *sphygmogram* (*sphygmos*, pulse), and the instrument by which it is made, a sphygmograph. The form of tracing obtained from a normal pulse is shown in Fig. 32. Each curve (*A* to *B*) represents one beat of the pulse, the initial rise of the line corresponding with the pulse as felt by the finger. The prominent notch on the descending side of the curve, called the dicrotic notch (*di*, twice; *croteo*, I knock), is probably due to the recoil of the column of blood as it strikes against the resistance caused by the minute arteries and capillaries, just as a wave is thrown back when it strikes against a wall. When the blood-pressure is very low and the vessels are badly filled with blood, this dicrotic shock may be so well marked as to be felt by the finger (dicrotic pulse), each beat conveying the sensation of two taps to the finger.

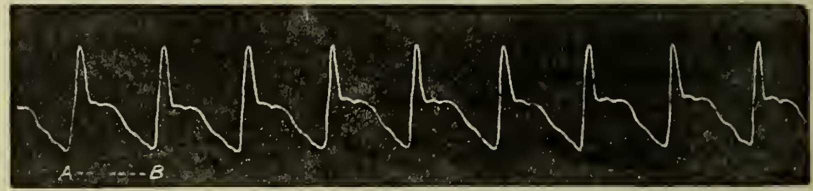

Fig. 32.—Pulse Tracing with Sphygmograph.

The heart and the arteries are under the **control** of the **nervous system.** In the lower animals, such as the frog and the tortoise, the muscle of the heart is capable of keeping up an automatic movement without influence from the nerves, and it is probable that in the higher animals also, including man, the beating of the heart is due to the property of the actual muscle of the organ. But the influence of certain nerves on the cardiac rhythm is well established. If, for example, the tenth (vagus or pneumogastric) nerves be cut through, the heart immediately starts beating more rapidly; if now an electric current be applied to that end of the cut nerve which is in connection with the heart, the frequency of the beat is reduced. Thus it appears that these nerves possess the power of slowing the heart's beat.

On the other hand, certain nerve fibres which supply the heart are derived from the special part of the nervous system known as the sympathetic (Vol. I., p. 225). Stimulation of these nerves causes a more rapid action of the heart; division of them, whereby their influence is removed, causes a slowing of the beat.

The arteries also are regulated by nerves, which produce contraction and relaxation of the muscle in their walls, and so diminish or enlarge the channel of the vessel. Thus, when a muscle is at work, the arteries supplying it dilate and more blood is brought to satisfy its needs. When the stomach is secreting its juice in the process of digestion, its wall becomes of a bright-pink colour, owing to the dilatation of the vessels running in it. When the body becomes hot, the vessels in the skin dilate; when it is cold they contract. Emotions may have the same effects, fear causing a paleness of the face, anger or shame a flush.

There is also a connection between the arteries and the heart by means of the nervous system, owing to which a condition of increased pressure in the vessels tends to cause a diminution in the force and frequency of the heart's action, while a low pressure tends to increase these.

The veins.—The structure of the veins is very similar to that of the arteries, but their walls are thinner, having less elastic and muscular tissue in them. The flow of blood through the veins is maintained principally by the pressure of the blood in the capillaries; that is to say, by the pumping action of the ventricle of the heart, and by the elastic pressure of the arterial walls. But the ventricles of the heart as they expand in diastole seem to exert a suction action on the blood in the auricles and great veins, just as an india-rubber ball in expanding sucks water into its cavity. The expansion of the chest in inspiration, too, has some effect in producing a suction of blood into the large thoracic veins.

Owing to these two last factors it sometimes happens that when a large vein in the neck is wounded, air is sucked into it and is carried to the heart; if the quantity of air is considerable, sudden death may ensue, the air in the ventricle preventing the heart from contracting properly on the blood contained within it and forcing it on into the arteries.

In the long veins which lead from the extremities to the heart a special arrangement exists to aid the return of blood; this consists in a series of pocket-like *valves* set in the vein, which allow the blood to pass in one direction only; every muscular movement presses on the column of blood in the vein, and forces the blood along towards the heart (Fig. 33).

Owing to the low pressure in the veins and to the fact that the force of the heart's beat is mostly expended in overcoming the resistance in the capillaries, blood issues from a cut vein in a steady stream, very different from the fountain-like jet that escapes from an artery; while the flow is easily arrested by light pressure, or even by elevating the part in which the wounded vein is situated. Veins are, as a rule, superficially situated, and are thus easily compressed by a light ligature round a limb, the effect of which is to cause engorgement of the veins on the side away from the heart. On the other hand, if the ligature is tight, the arteries also are compressed, and no blood can enter the limb, which is pale and bloodless. A tight ligature is therefore used in amputating a limb; a comparatively loose one preparatory to opening a vein (bleeding).

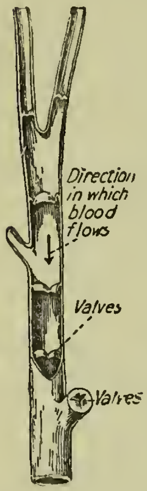

Fig. 33.—Veins Cut to Show Valves.

VI.—THE INTERNAL SECRETIONS

The action of glands such as the salivary glands, the pancreas, the liver, and the gastric glands, which possess well-marked excretory ducts, has already been considered; there are, however, in the body a number of glandular structures which are not so provided, but which apparently give rise to a secretion that is absorbed directly into the blood through the vessels, and utilised for the nutrition of other cells. Such are the thyroid gland, the suprarenal bodies, the thymus gland, and the pituitary body; while some organs which perform obvious excretory or secretory functions, such as the pancreas, the kidneys, the testes, and the ovaries, manufacture internal secretions as well. The existence of these is inferred from the disturbances which ensue if the various glands are removed or affected by disease.

The thyroid gland.—If the thyroid gland be removed from an animal or man, or if it atrophy owing to disease, the patient becomes dull and apathetic; the skin becomes dry and coarse, the hair falls out; the face loses its expression and becomes puffy and immobile; the hands become large and broad, and the subcutaneous tissue everywhere is swollen; the urine is scanty, and the bowels constipated, the pulse is slow, and the patient suffers from the cold and tends to crouch over the fire. If now the substance of the thyroid gland of some animal be administered as a remedy, all these symptoms, which make up the disease known as myxœdema, disappear, and the patient becomes once more bright and active. Hence it appears that the thyroid gland gives rise to some material which is of importance for the nutrition of the skin and the nervous system—both of which spring from the same rudiment in the embryo.

If, on the other hand, an excess of thyroid substance be administered, headache, flushing, and palpitation of the heart result—a condition closely resembling that found in the disease known as exophthalmic goitre, which is therefore probably due to excessive thyroid secretion.

The **thymus gland,** situated a little lower down than the thyroid, and lying within the chest, is well developed in infants, and gradually wastes away as they grow up. It is supposed to form some substance which is necessary for the developing tissues, but which is no longer needed when they are fully formed.

The **suprarenal bodies** consist of two parts—an outer cortex, formed of large glandular cells arranged in columns, and an inner part or medulla, closely connected with the sympathetic nervous system. In the condition known as Addison's disease, characterised by low blood-pressure, weak cardiac action and fainting, pigmentation of the skin, and attacks of vomiting and diarrhœa, the suprarenal bodies are found to be diseased.

It is possible to extract from the medulla of these bodies a substance, adrenalin, which has the property of causing constriction of the blood-vessels and consequent rise of blood-pressure. This may be regarded as the internal secretion of these glands.

The function of the cortical cells is not known.

The **pituitary body**, a single centrally-placed structure at the base of the brain, is said to be diseased in the condition known as acromegaly, in which there occurs great enlargement of the hands and feet, and of the bones of the face. It has been supposed that this gland provides a secretion which is in some way necessary for the growth of the bones; but the existence of this function is not satisfactorily established.

The pancreas.—If the pancreas of a dog or a cat be removed, a condition arises similar in all respects to the disease of mankind called diabetes; that is to say, there are great hunger and thirst, with passage of large quantities of urine containing sugar and other special chemical substances (acetone bodies), increasing weakness, rapid emaciation, and finally death in a comatose state.

If the ducts by which the digestive secretion of the pancreas is excreted are blocked, the above symptoms do not arise; this shows that it is not the absence of pancreatic juice from the intestine which gives rise to the disease. Further, if portions of the pancreas be removed separately, diabetes does not occur till all the gland is destroyed; and if, after the whole gland has been removed, a piece of living pancreas be grafted into the animal under the skin, no symptoms occur until the grafted portion has disappeared by gradual absorption.

From these facts it is inferred that the pancreas pours into the blood some internal secretion which has the property of controlling in some way the production or utilisation of sugar in the body. (It may be remembered that carbohydrate food is converted into sugar in the process of digestion.) It has been suggested that the internal secretion of the pancreas acts on the muscle-cells and enables them to take up sugar from the blood for their own nutrition. On the other hand, it is possible that the pancreas takes away from the blood some poisonous material which causes an increased output of sugar, some of which appears in the urine.

The kidneys.—Certain experiments on animals and some phenomena of disease suggest that the kidneys also form an internal secretion. Thus, if one whole kidney and a large portion of the other be removed in an animal, rapid wasting ensues, with passage of large quantities of urine containing an increased amount of urea. Since it seems impossible that a smaller amount of kidney-substance should merely extract from the blood a larger quantity of urea than a larger amount does normally, it is natural to suppose that the kidney in some way controls the production of urea in the body, which it can only do by forming an internal secretion.

Again, if a patient suffering from acute inflammation of the kidneys passes no urine, death occurs in two or three days with convulsions and coma (uræmia); whereas if both ureters are blocked, as sometimes happens, and consequently no urine is passed, the kidneys soon cease to form any, but the patient may live for two or three weeks, and die without uræmic symptoms. In the former case it is possible that the inflammation has so injured the kidneys that no internal secretion is formed, whereas in the latter the kidneys are uninjured, and can form their internal secretion, which enters the blood by the veins; consequently the absence of uræmia would appear to be due to continued presence of this material in the system. In other words, uræmia may be due to absence of renal secretion, just as myxœdema is due to absence of thyroid secretion.

There is some evidence that the **ovaries** produce a substance which is necessary for the nutrition of the fœtus, since miscarriage takes place if the ovaries are removed during pregnancy. Removal of the **testes** in infancy results in failure of development of male characteristics, such as the growth of hair on the face, deep voice, and muscular limbs.

VII.—MUSCLE

Movement is produced by the contraction of certain tissues, called muscles, some of which are attached to solid structures and cause movement of parts of the body (limbs) in relation to the rest, while others, which are arranged as coverings of hollow organs (stomach, bladder, intestine), produce contraction of their cavities and expulsion of their contents. Certain muscles, arranged as rings round the orifices of such organs, act as valves, preventing the escape of contents till the proper time (*e.g.* pylorus, sphincter of bladder) or protect openings such as the mouth, orbit, or pupil.

The muscles which move the limbs and a few others are under the control of the will and are called **voluntary muscles**, *i.e.* we can move them as we wish. Others, such as the muscles of the digestive tract, act automatically (**involuntary muscles**) under reflex control (p. 33) of the nervous system.

The heart forms a class by itself, probably acting by its own motive force, but controlled by nerves.

The voluntary and involuntary muscles differ somewhat in structure (Fig. 34). The former are bright red in colour, and are composed of elongated, rod-shaped cells, which show under the microscope a peculiar striped appearance (striation; *stria*, a stripe). These cells or fibres are enclosed in a fine sheath of transparent membrane (sarcolemma; *sarx*, muscle, *lemma*, receptacle). The cells of which involuntary muscle is composed are also elongated, and are pointed at their ends; they have no transverse striation.

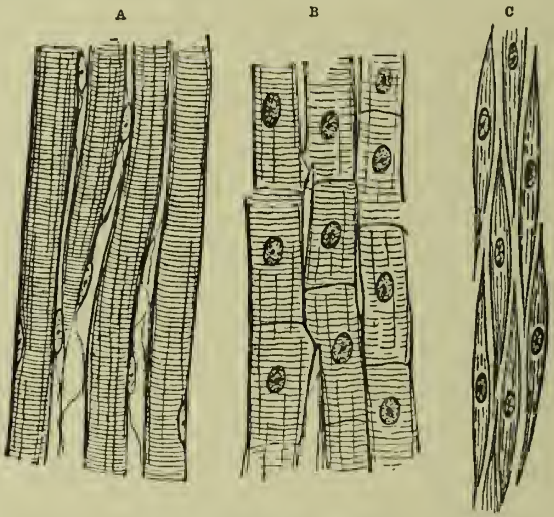

Fig. 34.—A, Striped Muscle; B, Heart Muscle; C, Involuntary Muscle.

The action of the two kinds of muscle is different, the striped muscles contracting rapidly so as to produce quick movements, the others slowly so as to give rise to long wave-like motions.

The muscle of the heart differs somewhat from both the other kinds. It is striated, but the cells are not of the rod-like form of voluntary muscle, but squarer, with a tendency to branch and form cross connections with fibres not lying in a direct line.

During life the contraction of a muscle is brought about by a stimulus conveyed to it by the nerve with which it is connected; and if a muscle with a piece of nerve attached be dissected out from the body of a recently-killed frog, it is possible to make the muscle contract by applying an electric current to the nerve. If a single momentary shock is applied, it is found that the contraction of the muscle is not instantaneous, but consists of a gradual shortening followed by a relaxation. If a second shock be applied before the relaxation has had time to occur, the muscle may shorten still more, the lengthening being delayed; and if a number of shocks are applied at very short intervals, the muscle remains permanently contracted; it is then said to be in a state of *tetanus* or of tonic (*tonos*, stretching) contraction. A muscle cannot maintain this condition for an indefinite time; it becomes fatigued, and relaxation gradually ensues in spite of the continued stimulus.

The same effect is experienced during life; it is impossible to maintain a muscular contraction for long without a rest. Even the heart-muscle has to rest, only its rest is obtained during diastole—an arrangement of alternate work and rest for momentary periods throughout life.

Besides the stimulus derived from the nerve, there are other means of causing contraction of muscle, as by applying certain chemicals (strong salt-solution, ammonia) directly to the muscle, or by pinching or striking it. Involuntary muscle responds to the same influences, but its contractions are very slow, the periods of contraction and relaxation together lasting perhaps two or three minutes.

The exact manner in which the contraction of muscle is brought about is not known, but it is by means of some chemical change occurring in it. A muscle in contracting gives off carbonic acid, and also forms a certain quantity of lactic acid (the acid which occurs in sour milk) in the process. Oxygen is necessary for its activity, as for that of other tissues. If a muscle be removed from the body it quickly alters in appearance and character, becoming stiff and dull-looking, instead of elastic and gelatinous. The same change takes place within the body after death, and is known as *rigor mortis* (stiffness of death). It seems to be produced by a clotting of the semi-fluid substance of the muscle, analogous to the clotting of the blood.

Rigor mortis indicates death of the muscle; it lasts for some hours or even days, and then passes off as putrefaction occurs. Hence a dead body loses its stiffness in the course of one or two days.

VIII.—THE NERVOUS SYSTEM

The nervous system provides the mechanism by which a stimulus applied to one part of the body is conveyed to another part lying at some distance, so as to produce a movement. The central nervous system, consisting of the brain and spinal cord, may be compared to a telephone exchange; the person who rings up the exchange is represented by a stimulus applied to a nerve which passes from, say, the skin to the brain or spinal cord (the exchange). In this exchange connection is made with another part of the body, a muscle, by means of a second nerve which carries the stimulus from the central nervous system to the appropriate part.

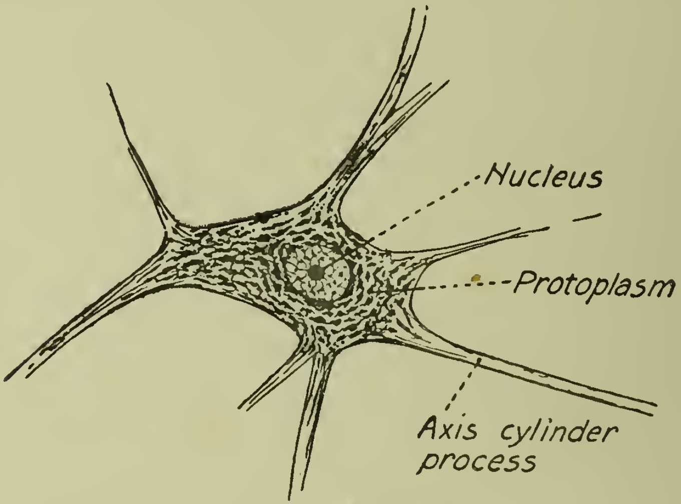

Fig. 35.—Nerve-Cell.

The nerves which convey stimuli to the central nervous system are called **sensory** or **afferent** (*affero*, I carry to) nerves; those which pass it on from the brain or cord to the muscles are called **motor** or **efferent** (*effero*, I carry away from) nerves.

Just as in speaking through the telephone we cannot use the wire directly, but must have a special instrument to transform the sounds of the voice into electrical vibrations, so special organs are needed to transform the stimuli which act upon the skin into nervous impulses. For this purpose the sensory nerves end in different ways according to the kind of stimulus which they have to transform. In the eye there is a complicated arrangement of minute rods and cones which transform rays of light into nerve-force ; in the tongue there are so-called taste-buds ; in the skin, "tactile corpuscles." And just as the listener at the other end of the telephone has to be provided with a special apparatus to transform the electrical vibrations once more into sound, so the motor nerves end in peculiar structures ("end-plates") which are in contact with the muscles and enable the nervous impulse to throw them into motion.

The nervous system, like all other organs of the body, is made up of living cells; and, in order that these cells may convey impulses over long distances, it is necessary that the cells should be of great length. A typical nerve-cell consists of a **body**—nucleus and protoplasm—from which proceeds in the first place a long process, called the **axis-cylinder,** and secondly a number of short outgrowths, which branch like the twigs of a tree ; these last serve both to take up nutriment for the use of the cell from the surrounding lymph, and also to make connection with neighbouring nerve-cells, so that stimuli are passed from one to another (Fig. 35).

Just as the wires connected with a telephone are covered with silk to insulate them, i.e. to prevent the electricity from escaping and being lost, so the nerve-fibrils are covered with a special sheath consisting of a fatty material (*myelin* or *medulla*). Nerves thus covered are known as **medullated nerves**, the axis-cylinder with its sheath of medulla constituting a **nerve-fibre.**

A **nerve** as seen with the naked eye, and as it can be dissected out from a limb, is made up of a large number of such fibres bound together in bundles by a sheath of connective tissue. The medullary sheath appears to be formed by a series of special cells which fold themselves round the axis-cylinder, and, owing to this, slight constrictions are visible along the sheath at regular intervals where these cells join one another ("nodes of Ranvier"). Outside the medullary sheath of each fibre is a fine membranous covering called the **neurilemma** (*neuron*, nerve ; *lemma*, sheath or receptacle).

A stimulus passing along a nerve is accompanied by a definite electrical change. By observing this it is possible to ascertain the rate at which an impulse passes along a nerve. This rate is between 30 and 40 yards in a second. If a motor nerve is destroyed, the muscle which it supplies will be paralysed, *i.e.* it cannot be moved ; if a sensory nerve is destroyed, stimuli from the area of skin to which it is distributed cannot be carried to the brain, *i.e.* there is loss of sensation (anæsthesia).

THE SPINAL CORD

In lower animals, such as the worm or centipede, the body is made up of a series of segments or rings, arranged one behind the other, the front segments being modified so as to form head, mouth, etc. In each segment there is situated a small mass or ganglion of nerve-substance, from which nerves run round the segment on either side, supplying that individual segment. In the front segment is a rather larger mass of nervous matter, representing a brain. The separate ganglia are united one to another by strands of nervous substance.

In the higher animals the segmental ganglia are fused into a single structure, the cerebro-spinal axis, consisting of the brain and the spinal cord, but the nerves of the segments persist and may be seen issuing from the spinal cord in a series of pairs. Each spinal nerve arises by two distinct roots from the cord, one root coming from the front, the other from the back of the cord ; the two roots then join together to form a single trunk. The anterior or front root contains only motor fibres, the posterior only sensory fibres ; each spinal nerve, therefore, contains fibres of both kinds.

If the spinal cord be cut across, it is seen that its substance is composed of two kinds of matter. In the centre is a quantity of greyish material, the **grey matter,** arranged in the form of an X, the central part of the letter being thickened out of proportion to the limbs. The form of the grey matter has also been compared with that of a butterfly (Fig. 37). The two prolongations which project forwards are called the *anterior horns* of the grey matter, the two which point backwards the *posterior horns.* From the anterior horns arise the anterior or motor roots of the spinal nerves, from the posterior horns the posterior or sensory roots. In the anterior horns are situated many large nerve-cells, the long processes (axis-cylinders) from which run down in the anterior roots. The cell-bodies of the nerve-fibres in the posterior roots are contained in *ganglia* or swellings situated on the posterior roots, their long processes running in a T-shaped arrangement (Fig. 36) both inwards into the posterior horns, and also downwards in the spinal nerves, accompanying the motor fibres.

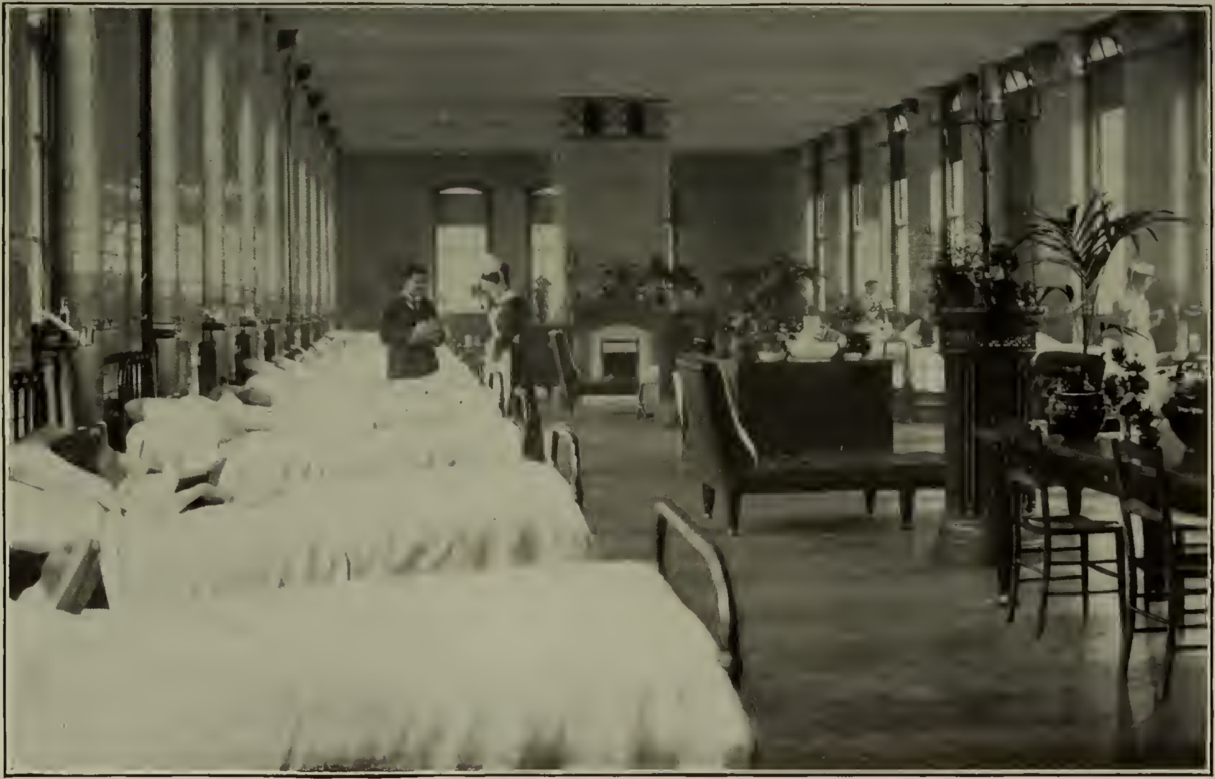

PLATE XXIV.—THE "CLARENCE" WARD IN THE LIVERPOOL ROYAL INFIRMARY.

The **white matter** of the spinal cord surrounds the grey, and makes up the rest of its substance. It consists of medullated nerve-fibres, some running downwards from the brain to the limbs and body, others bearing impulses upwards from these parts to the brain. These descending and ascending fibres are arranged in bundles or tracts occupying special portions of the cord. The *sensory* or *ascending* fibres lie principally in the part of the cord between the posterior roots, and in a thin layer on the edge of the lateral portions; the *motor* or *descending* fibres lie chiefly in two large bundles at either side of the grey matter, and in two small tracts one on each side of the anterior fissure.

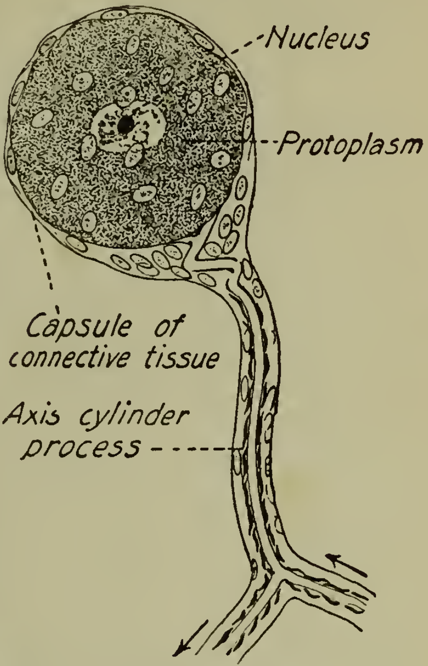

Fig. 36.—A Sensory Nerve-Cell with T-shaped Process.

Reflex action.—Since the object of the nervous system is the production of movement in one part of the body—the muscle—in response to a stimulus acting on another part—the skin—the simplest form of action is that in which an impulse is conveyed to a segment of the spinal cord by a sensory nerve, entering by a posterior root, and is then directly returned (reflected) along a motor nerve, emerging by an anterior root, to the proper muscle. Such a simple process is called a reflex action (Fig. 37); it takes place spontaneously, without any effort of the will. Examples of such actions in ordinary life are seen in the movement of the leg which follows tickling the sole of the foot, and in the closure of the eye which occurs when anything is suddenly brought near it

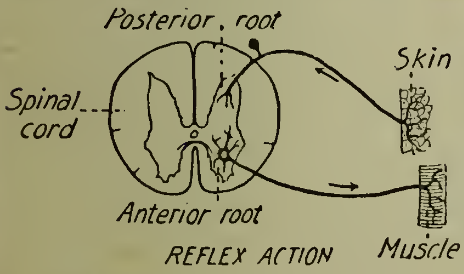

Fig. 37.—Diagram illustrating Reflex Action.

(though in this second instance the reflex is brought about by the brain itself, not by the spinal cord).

It seems, however, that in the normal person reflex actions are to some extent modified by the unconscious influence of the brain, since they occur much more briskly in an animal which has had the brain removed or in a patient who has suffered from some accident which has cut off the brain's influence from the cord.

Voluntary action.—Voluntary action, in which the will is brought into play, is more complicated than reflex (Fig. 38). We may take such an example as a sensation of itching on the hand, which causes a conscious effort to scratch it. In this case the sensory stimulus is carried to the spinal cord by an afferent nerve, but, instead of being immediately reflected down a motor nerve, it is first carried up to the brain, where it becomes a sensation—a stimulus of which we are conscious. This sensory disturbance is transmitted to a special area of the brain from which motor nerves proceed, and is thus carried down again to a point in the spinal cord from which the motor nerves to the muscles appropriate for the action of scratching are given off. The impulse thus travels through a much longer circuit than the simple reflex.

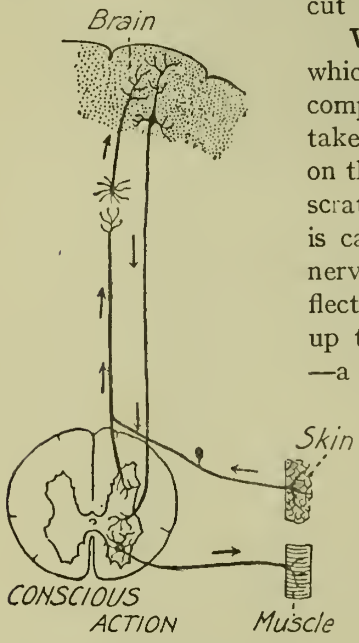

Fig. 38.—Diagram illustrating Conscious Action.

Varieties of sensation.—It is usual to speak of the five senses—touch, sight, hearing, taste, and smell. A little more analysis is, however, necessary when the matter is considered physiologically. By the sense of touch, localised chiefly in the skin, we recognise the resistance (hardness or softness) and the shape of things. But by touch we also recognise whether a thing is hot or cold. Further, violent stimuli applied to the skin cause pain. Now, it might seem at first sight that the same nerve fibres would convey all these different kinds of stimuli to the brain, but this is apparently not the case. In a certain disease of the spinal cord, the patient may retain his sense of touch unimpaired, but may lose the power of appreciating heat and cold, as well as that of feeling pain; he may burn his fingers on a hot iron or prick them with a needle without feeling more than a sense of contact with a hard object. Hence the nerves of *touch*, of *temperature*, and of *pain* are apparently distinct.

Further, we are able, without touching anything, to know the position in which our limbs are placed; thus we can tell with our eyes shut whether our hand is closed or open, whether a leg is bent or straight. This power depends on a special sense called *muscular sensation*. Patients who have lost it, as in locomotor ataxy, cannot stand with their eyes shut, because they cannot tell the position of their bodies, and consequently tend to sway about and to fall down. It appears that impulses from these nerves of muscle-sense are carried up in the spinal cord by the columns of white matter situated between the posterior root (posterior columns). The nerves of touch run on the outside of the cord on either side, and sensations of heat and cold and of pain are perhaps conveyed by the grey matter itself.

The spinal cord, conveying as it does impulses from the brain to the body and limbs (motor), and from the limbs and trunk to the brain (sensory), may be compared with a railway with two lines of rails, on one of which trains run from the provinces up to London, on the other down from the capital to the country. If then the spinal cord be cut across, impulses cannot run in either direction; it is as if both lines were blocked. The result will be that below the point of injury the body and limbs will receive no voluntary impulses, the brain will be unable to set the muscles in action; in other words, there will be paralysis below the injury. At the same time the brain will receive no sensory impulses from the limbs, so that the sufferer will complain of loss of feeling in the lower parts. But the reflex action of the cord will remain; so that if one foot be tickled the leg will move automatically, although the patient is not conscious of any sensation, and makes no attempt to move the limb.

THE BRAIN (PLATES XX., XXI., VOL. I.)

Like the spinal cord, the brain consists of grey and of white matter; but in the brain the grey matter is situated externally, forming a layer some ¼ inch thick over the surface. The curiously folded (convoluted) surface of the brain provides an arrangement by which the extent of surface is increased, and so more grey matter is obtained. In the lower animals and in idiots the convolutions are much less marked. The grey matter contains a large number of nerve-cells; the white substance consists of their processes, the nerve-fibres.

The brain is the seat of consciousness, embracing sensation, perception, emotion, judgment, and voluntary action. Although it is the seat of sensation, yet it is not itself sensible to pain, as its surface can be cut or burnt without producing suffering.

The motor area.—It has been found possible to discover the special functions of certain parts of the brain, partly by experiments upon animals, partly by observing the effects which ensue on destruction of different parts by disease. By stimulating certain parts of the surface with an electric current, movements are produced, different muscles responding to application of the current to different spots on the brain. By this means a region lying about the centre of the lateral aspect of the cerebral hemispheres has been marked out as the "motor area." It embraces the convolutions on either side of the fissure of Rolando, as well as a small portion of the inner surface of each hemisphere continuous with this, and a portion of the lower convolution of the frontal lobes, also adjoining (Fig. 39). The upper part of this area on each side presides over the movement of the leg, the central part over that of the arm, and the lowest part over that of the face, a special area on the left side, the speech centre, being concerned in the movements by which spoken words are produced.

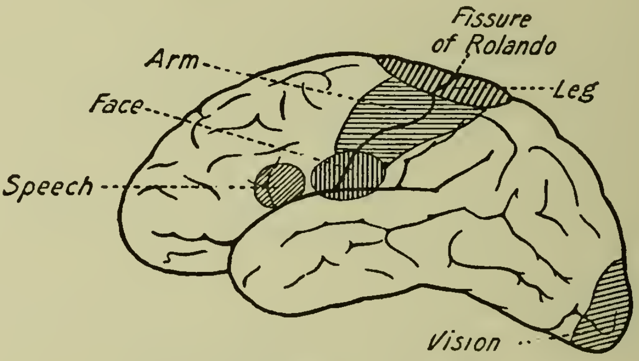

Fig. 39.—Cerebral Localisation.

But it is found that the areas on each side of the brain preside over movements in the limbs and face of the *opposite side*, the left hemisphere causing movement of the right leg and arm, and the right hemisphere innervating the left leg, etc. The reason for this is as follows:—In the motor areas are situated large nerve-cells; these give off long processes

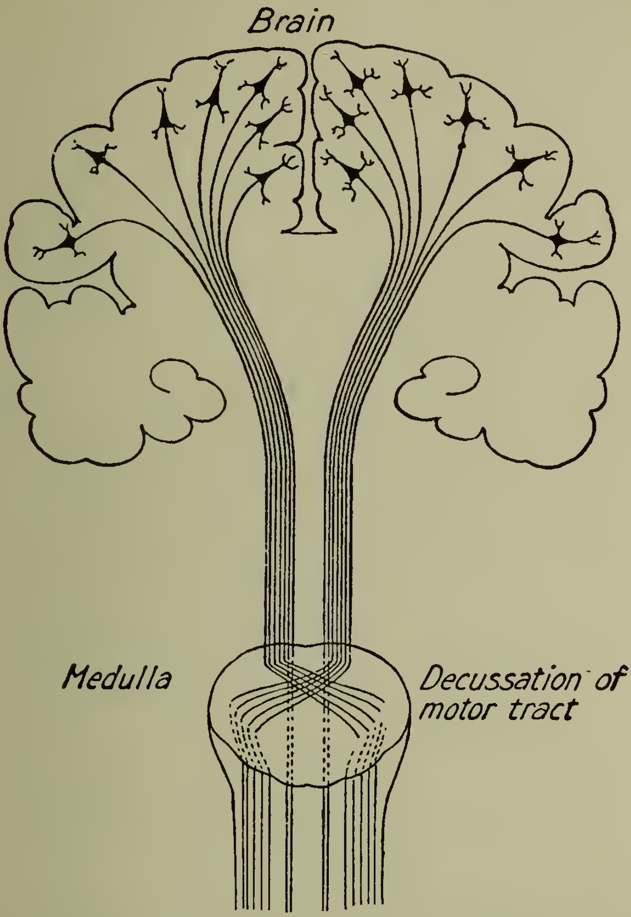

Fig. 40.—Diagram illustrating the Crossing-over of Motor Fibres in the Bulb.

which run down in the spinal cord and communicate with the cells in the anterior horns which work the muscles of the limbs. But these fibres do not run down on the same side as they originate; they cross over in the upper part of the spinal cord (called the bulb or medulla oblongata) to the opposite side, and then run down in the so-called lateral columns to which reference has already been made. A few fibres do, however, go down on the same side in the two small tracts which lie on either side of the anterior fissure (Fig. 40).

Other special regions.—A large part of the *posterior region* of each hemisphere is concerned with the function of vision. If one occipital lobe is destroyed, it is found that partial blindness is produced, the blind portion of each eye being that half of the retina which lies on the same side as the lobe that is destroyed. Thus, if we suppose both eyes cut in halves through their centres, the cut passing vertically through the pupil in front and the retina behind, then if the left occipital lobe is destroyed the left halves of both eyes will be blind. This is owing to the fact that the nerve-fibres from the inner halves (next the nose) of the eyes pass across to the opposite side of the brain while the outer fibres run on the same side.

The sense of hearing is apparently localised in the *temporal lobes.* The *frontal lobes* are supposed to be concerned with the intellectual faculties.

Connecting fibres run between the cells of the different regions. For example, in reading aloud it is necessary for an impulse to be carried from the centre for sight to that for speech, while in answering a question there is need for connection between the hearing centre and that for speaking. There are also fibres of connection between the two halves of the brain. A large part of the brain altogether is formed by these so-called *association-fibres*, as it is by such association that thought and judgment are rendered possible.

Habit.—An important property of nervous tissue is that whereby, when a cell or a group of cells has once responded in a particular way to a stimulus, it becomes more easy for it to react in the same way to that stimulus in the future; and the more often a reaction takes place, the more does it tend to become spontaneous on future occasions. In this way habits are formed, and an action, which was at first learned with difficulty, becomes easy in course of time, and may be performed almost without conscious effort. A child learns with difficulty to walk or to talk, but in course of time walking becomes automatic, and we walk without thinking of the different muscular movements required; while we are equally unconscious of the acts of tongue, lips, and larynx by which words are formed. The value of education (apart from the minor use of acquiring a knowledge of particular truths) is in the cultivation of good habits, so that right action becomes in ordinary circumstances almost instinctive.

The power of **memory** probably depends on practically the same property, cells which have once been stimulated to a certain form of consciousness tending to revive that impression when the stimulus is repeated. Here, too, the *association* of the different cell-groups is of importance, as we see in those instances in which, for example, a remembered scent recalls the circumstances in which it was long ago perceived—the idea of the scent being associated with the memory of the surrounding conditions, and one recalling the other to consciousness.

The cranial nerves.—From the base of the brain are given off a series of pairs of nerve-trunks possessing different functions. The first two so-called nerves, those to the nose and the eye, are in reality projections of the brain-substance itself. The third pair of nerves governs the movements of most of the muscles of the eye, including the muscle which is concerned in "accommodation" (p. 40); but the fourth and sixth pairs also supply individual ocular muscles, the sixth turning the eyeball outwards away from the nose. The fifth pair carries sensory impulses from all parts of the face, and a special branch of this trunk moves the muscles of mastication. The seventh pair (facial) supplies the movements of the muscles of expression, including the buccinator muscle, which is also of importance in the act of eating. The eighth nerves are those of hearing, the ninth of taste. The tenth, called also the vagus or pneumogastric nerves have a long course, running down along the œsophagus and supplying the lungs, heart, and stomach, as well as giving branches to the larynx. The eleventh or spinal accessory pair supplies some of the muscles of the neck and of the palate, while the twelfth pair governs the movement of the muscles of the tongue.

SYMPATHETIC SYSTEM

The sympathetic system (Vol. I., p. 225) is a series of ganglia or masses of nerve-cells, linked together, and corresponding with the segments of the body. From these ganglia nerves pass to the blood-vessels, which they have the power of contracting; to the heart, which they stimulate; to the iris, which they dilate; and to some glands, such as the submaxillary salivary gland, in which they cause the secretion of a thick, viscid form of saliva.

END-ORGANS OF NERVES

It has already been mentioned that whereas all nerves transmit impulses in the same manner, the kind of stimuli to which they respond depends on the special modifications in which they terminate. The motor nerves supplying the muscles break up into minute twigs which end in the muscular cells. In among these fibres are also to be seen little spindle-shaped bodies which are the terminations of the sensory nerves, by which we are conscious of the position of the limbs (Muscular sense, p. 35). In the skin the nerves of touch end in little globular bodies, which appear to be formed of concentric layers like the skins of an onion ; and very similar bodies form the terminations of the fibres of the nerve of taste. In the case of sight and hearing, very special apparatus is necessary for the conversion of light- and sound-waves into nervous force, and these organs must now be described.

The eye (Plate XXIII., Vol. I.).—The principle upon which the eye is constructed is the same as that of a photographic camera. In the latter there is a lens in front which throws a picture upon a sensitive plate at the back of the camera, which is simply a box the sides of which are blackened so as to cut off stray rays of light. In the eye the sensitive plate is the retina, a process of the brain itself. The woodwork of the camera is represented by the firm external coat (*sclerotic*) of the eye, and a layer of black pigment serves the same purpose as the black lining of the camera.

Now, in order that a lens should throw a sharp picture on a screen situated at a particular distance from it, it is necessary that the object of the picture should be a certain distance away ; all other things are more or less "out of focus." In the camera there is an arrangement by which the lens can be moved either nearer to or farther from the plate, so that it can form pictures of objects at varying distances. In the eye the same power is obtained in a different way ; there is an arrangement by which the shape of the lens itself is altered, so as to bring now nearer, now more distant, objects to a focus on the retina. This power of altering the curvature of the lens is called the faculty of *accommodation*. Behind the lens in a camera is placed a disc of metal with a small hole in the centre (diaphragm), the use of which is to cut off rays of light which would tend to pass through the marginal portions of the lens, and which would spoil the clearness of the picture formed. The same object is attained in the eye by the action of the iris—the coloured part of the eye as seen from in front—which forms a circular curtain, capable of expanding or contracting its aperture according to the weakness or intensity of the light to which the eye is exposed.

The *iris* (Lat., a rainbow) consists of muscular fibres, some of which run in circles round the pupil, others running radially outwards. The circular fibres are under the control of the third nerve, and by their contraction cause narrowing of the pupil. The radiating fibres are innervated by the sympathetic and cause widening of the aperture. When a bright light falls on the eye, the circular fibres contract spontaneously (reflexly); this reaction of the pupil is lost in some diseases. In looking at a near object the pupil contracts, and in looking at a more distant one it expands (accommodation-reflex). Certain drugs, such as atropine and cocaine, cause dilatation of the pupil; others, such as opium and physostigmine, contract it.

In certain persons known as "albinos" there is no pigment in the iris, and in them the pupils are always contracted; the eyes have a pink appearance owing to the red colour of the blood-vessels showing through in the absence of pigment. In children the pupils are often more widely dilated, normally, than in adults; in old persons they are often contracted. The iris hangs loose in a cavity (anterior chamber) filled with clear watery fluid—the aqueous humour—which bathes the front of the lens, and is bounded in front by the cornea.

The *conjunctiva*, the membrane with which the outer surface of the front of the eye is covered (except the cornea), is kept constantly moist by the tears. These are secreted by a special gland, the lachrymal gland (*lacryma*, a tear), situated at the upper and outer corner of the orbit. Normally we are not conscious of the secretion of tears, the fluid draining away by means of two little ducts situated at the inner angles of the eyes, on the inner surfaces of the eyelids, by which the tears are drained into the nose. The secretion of tears is increased by contact of the conjunctiva with any foreign body (dust, etc.), by emotions, and by stimuli affecting the nose (mustard, pepper). In such circumstances the tears are poured out too fast for the lachrymal ducts to drain off, and then they escape over the cheeks.

The constant blinking action of the eyelids, combined with the secretion of tears, keeps the front of the eyes free from irritating particles, and protects the eyes from the action of harmful bacteria. If the eyelids cannot be moved or do not properly cover the eyes, inflammation of the conjunctiva may occur ; this may be met with in paralysis of the facial nerve, which is mainly concerned in closing the eye.

The *lens* is a firm, transparent, oval body, suspended by a thin membrane or capsule from the firm outer coat of the eye. All round at the zone of suspension are arranged a series of muscle fibres, which by their contraction pull upon the capsule and thus tend to draw the edges of the lens outwards. By this action they alter the shape of the lens, rendering it thinner and flatter, just as an oval piece of india-rubber would be flattened if pulled upon by the fingers. And in the same way also the lens, which is an elastic body, tends to return to its original shape when the muscle ceases to act. By the action of this muscle, known as the *ciliary muscle*, is produced that change of shape in the lens which is necessary for accommodation. The lens itself is composed of transparent fibres arranged in concentric circles. In certain diseased conditions the fibres may become opaque, and the patient is said to suffer from cataract.

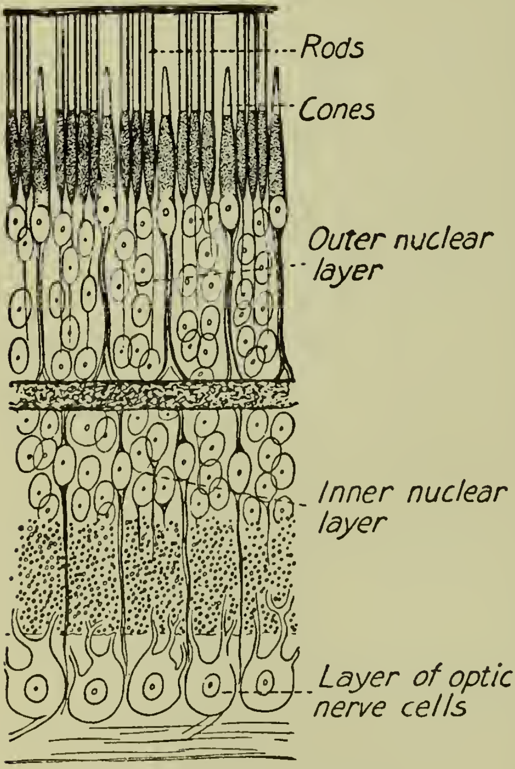

Fig. 41.—The Retina, Magnified.

Behind the lens is situated a mass of clear jelly-like material, called the *vitreous* or glassy humour, which fills up the space between the lens and the retina.

The *retina* (Fig. 41): This process of the brain consists of three layers of cells, the most characteristic of which give off processes that are modified in a special manner in order to act as transformers of light-energy into nervous force. These terminals take the form of short, blunt enlargements called " cones," and longer, straight processes called " rods." The other two layers of cells act as transmitting fibres for conveyance to the brain of the stimuli produced by the action of light upon the rods and cones. The picture formed by the lens is focussed on the layer of rods and cones. When light falls on the retina, the cones shrink up ; when the eye is kept in the dark, they expand again. Lying among the rods (which rest against the black pigmented coat of the eye) is a quantity of peculiar purple pigment (visual purple or rhodopsin). By the action of light this colouring matter is bleached, but the colour returns in the dark. The exact connection between this change and the act of seeing is not known. It has been suggested that the cones appreciate differences of colour, the rods changes of light and darkness.

The point of most accurate vision is a spot at the centre of the retina, called the *fovea centralis* or central pit ; here there are only cones present. To the inner side of this spot is the point at which the optic nerve enters the eye ; it is visible when the eye is examined with the ophthalmoscope as a pale-pink or whitish round disc, from the centre of which arteries and veins radiate outwards over the retina. In this area there are no rods or cones, and the spot is insensitive to light, forming the so-called *blind spot.*

The existence of this blind spot can be shown by drawing on a piece of paper two black spots about three inches apart. Then if one eye be shut, and the remaining eye be fixed upon one of the spots (the left-hand spot for the right eye, the right-hand spot for the left eye), while the paper is brought from a distance of a foot to a point an inch or so from the eye, it will be found that the second spot disappears from view at a certain distance, and reappears again as the paper is brought closer still. The disappearance is due to the image of the second spot falling on the optic disc.

Normally the images formed on the two eyes by one object fall on corresponding points on the two retinas, and the brain fuses the two images into a single mental picture. If, however, the muscles of either eye do not act properly, the two eyes will not move together as they ought to do (squint), and the images will fall on points of the retinas which do not correspond ; in such a condition the brain will perceive two separate pictures of one object, and the patient will " see double " (*diplopia—diploos*, double ; *ops*, sight).

When a bright light falls on the retina, the sensation produced lasts longer than the actual stimulus; consequently, if a brightly illuminated point is moved rapidly (as by whirling round a glowing piece of charcoal), the image formed at one point has not died away before another is formed at another point, and the result is the appearance of a circle of fire.

In looking at a near object, it is necessary to turn the eyes a little inwards so as to fix them both on it, and this act of convergence needs the exercise of some muscular power. We are conscious of the effort involved, and learn to recognise the distance of an object by the amount of effort required to "fix" it. Hence, when one eye is lost or shut, it is difficult to judge distances exactly, as may be seen if one eye be shut, and an attempt made to touch with the finger-tip a small object held in front of the observer.

The ear (Plate XXIII., Vol. I.).—The ear is a complicated organ, inasmuch as the inner part of it subserves two distinct purposes—that of hearing, and that of maintaining the equilibrium of the body. The parts which are employed in the former office are the outer ear or pinna, the external passage or auditory meatus, the drum, the ossicles, and the cochlea, with the fluid which it contains. The equilibrising apparatus consists of the semicircular canals with the fluid which is enclosed within them.

The *pinna* or *external ear* is in man a comparatively insignificant organ compared with what it is in many of the lower animals. In these it is a movable structure, worked by important muscles; these muscles in man are atrophied, so as to be useless, and indeed practically immobile, except in certain abnormal individuals who can move their ears. The purpose of the pinna is to collect the waves of sound and facilitate their passage into the *meatus* (passage, Lat.). This passage leads to the *drum* or *membrana tympani*, a tense membrane readily thrown into vibrations by sound-waves falling upon it; it forms a partition between the external meatus and the *cavity* of the tympanum, situated in the temporal bone. This cavity is filled with air, and it is of importance for the proper working of the drum that the air on the inside of it (in the tympanic cavity) should be kept at the same degree of pressure as that in the meatus outside. This condition of things is maintained by means of the *Eustachian tube*, leading from the pharynx, just behind the posterior opening of the nostril, into the tympanic cavity, which is thus placed in direct communication with the outer air. If the Eustachian tube becomes blocked, as it may in patients suffering from a cold or other affection of the pharynx, partial

Ennumerate the various foodstuffs contained in yesterdays meals.

a

Breakfast:

Food	Proteids	Carbo Hydrates	Fats	Salts water
Bread	Gluten	1. Starch 2 Sugar		Common salt water
Butter			Cream	Salt· water
Eggs	1 albumin 2 Globulin			Salts & water
Milk	1 Casein 2 Lactalbumen	Lactose	cream	salts & water

Tea contains a stimulent called Theine in small quantities

Dinner

Meat	1. Fibrin 2. Myosin 3. Blood albumen		animal fat	salts.
Pearl Barley	1. Gluten	Starch maltose		
Potatos		Starch		Salts water
Pastry	Gluten	Starch Sugar		Salts water
Mamarlade or Jam		sugar		various fruits salts & water.

deafness results, the air inside the tympanum becoming gradually absorbed.

In order that the tympanic membrane may be free to vibrate, and may yet be brought into connection with the internal ear, a sort of bridge is formed across the tympanic cavity by means of three small bones (ossicles), which articulate one with the other in such a way that they carry the vibrations of the tympanum to the corresponding membrane which covers the opening of the internal ear (the *fenestra ovalis* or oval window), but diminish the strength of the vibrations so as to adapt them to the delicate apparatus within. By the membrane covering the fenestra ovalis the vibrations are conveyed to the fluid which fills the internal ear.

The *internal ear*, so far as hearing is concerned, consists of a tapering tube, filled with fluid, lying in a bony canal. This canal (*cochlea :* Lat. = snail-shell) is shaped almost exactly like a snail-shell ; it is larger at the bottom than at the top, and is coiled upon itself (Plate XXIII.). The winding tube thus formed is divided into two parts by a shelf or partition which springs from the central column of bone, round which the tube is curled, and extends across to the outer wall. On this shelf are placed the special cells which form the terminal organs of the auditory nerve. These cells are provided with minute bristles at their free extremities, and are called "hair-cells." The fibres of the auditory nerve run in the central bony column of the cochlea, and send branches to these cells, which lie in a continuous row throughout the whole length of the central portion of the cochlear canal. The method by which different notes and sounds are received and distinguished by these cells is not known. Evidently the vibrations which constitute sound are transmitted by the fluid in the internal ear to the terminal bristles of the hair-cells, and the shape of the cochlea, gradually narrowing, suggests that the cells at different levels respond to tones of different pitch.

Sound can be transmitted to the fluid in the ear, not only by the tympanum and the row of ossicles, but also directly through the bones of the skull. Thus, if a vibrating tuning-fork be placed over the bone of the mastoid process or on the forehead, its sound is heard, even when the external ear is plugged with wool, or when the ossicles are destroyed by disease.

The stimuli which are perceptible to the ear, and therefore constitute "sounds," range between 30 and 30,000 vibrations per second;

but individuals differ in the range of sounds which they can hear; thus some persons cannot hear the cry of a bat owing to its high pitch.

Semicircular canals.—The other portion of the internal ear is concerned with maintenance of the equilibrium of the body—the consciousness of the direction of movements made, and of the position in which the head is placed. It consists of an arrangement of three loop-shaped channels in the temporal bone, lined with membrane, and filled with the same fluid which fills the cochlea. The three semicircular canals, as they are called, are arranged in a manner which has been compared with the curved sides and rounded anterior border presented by an ordinary "corner wash-stand." Two of the canals may be regarded as lying in vertical planes at right angles to one another, while the third lies in a horizontal plane. Each semicircular canal has at one end an enlargement or bulb (*ampulla*) in which are placed the cells that form the end-organs of the special branch of the eighth nerve, supplying the canals. These cells are furnished with long bristles, which are acted upon by the currents formed in the fluid (endolymph) filling the canals. Consequently, whenever the head is moved, a stimulus is conveyed to the cells of one of the semicircular canals, and by them is passed on through the eighth nerve to the cerebellum, by which the function of maintaining equilibrium is performed.

IX.—REPRODUCTION

It was seen that in the amœba new individuals were formed by the splitting of the parent-cell into two. The same process is seen in the cells which form the tissues of the higher animals. New cells are formed by division of those previously existing. The process of division is somewhat complicated. The substance of the nucleus first arranges itself in the form of a thread or ribbon, which then divides into separate portions, each taking the shape of a letter V. These V-shaped pieces of the nucleus then split throughout their whole length, each forming two complete V's, and the resulting halves group themselves in two clusters, one of which moves to one end of the cell, the other to the opposite. Then the protoplasm of the cell divides so that each of the resulting halves contains one of the groups of nuclear fragments, these fragments fuse together so as to form a single nucleus in each of the resulting new cells, and the process of division is complete.

For the production of a new individual, special cells are set apart, those of the male being situated in the testes, those of the female in the ovary. The cells of the ovary are known as **ova** (*ovum*, an egg), those of the testes give rise to minute, actively-moving, thread-like bodies called **spermatozoa** (*sperma*, seed; *zoon*, an animal). In order that a new individual should be formed, it is necessary that the nuclear matter of the ovum should unite with that of the spermatozoon, and when this process of fertilisation has occurred, the resulting nucleus, formed by the union of the original two nuclei (male and female), proceeds to divide, just as has been described in the case of other cells.

By continued division and subdivision a mass of cells is formed, which become arranged in three primary layers, called respectively the **epiblast** or outer layer, the **mesoblast** or middle layer, and the **hypoblast** or inner layer (*epi*, upon; *mesos*, middle; *hypo*, under; *blastos*, a sprout or bud); the flat disc formed by the three layers rapidly becoming folded on itself, so as to form a hollow body. Nutrition of the developing cells is maintained by the formation of blood-vessels which are brought into close relation with those of the mother, so that food and oxygen can be conveyed from her to the fœtus.

By further development the three layers of the embryo give rise to different tissues—the epiblast forming the skin and the nervous system; the hypoblast, the mucous membrane of the alimentary canal and the organs connected with digestion; the mesoblast, the muscles, bones, and other parts.

Thus all the cells of the body are derived from one original cell, but as they develop they take on different characters, enabling them to perform special duties of movement, secretion, and so forth, according to the different tissues which they go to form.

CHAPTER XIV

ELEMENTARY BACTERIOLOGY

By Charles Slater, M.A., M.B.(Cantab.), M.R.C.S., F.C.S.

Introductory—Bacteria or Schizophytes—Pathogenic Bacteria and their Products—Vaccines and Antitoxins—Cultivation of Bacteria—Antiseptics—Disinfectants or Germicides—Sterilisation by Heat—Filtration.

I.—INTRODUCTORY

The way in which the occurrence of a single case of an infectious disease is followed by a series of similar cases, until an infected community is swept by the epidemic, irresistibly suggests that the cause of such a disease must be alive, since it is only in living material that this capacity for unlimited and specific increase is found. The idea that it is a living organism—a *contagium vivum*—which produces such epidemic diseases is of very great antiquity. But, though the idea was old and was supported by many arguments from analogy, the proof of its truth is comparatively modern. The first steps along the path of demonstration were taken by the Delft weaver Leeuwenhoek, who in 1695, by means of lenses ground by his own hands, examined a large number of human and animal discharges, saliva, tartar of teeth, and other materials. He described with great clearness and admirable drawings a large number of the organisms which are now called bacteria, and communicated his discoveries in a series of papers sent to the Royal Society of London, then in its early years. From this time onwards a great many observers—some, such as Needham and the Abbé Spallanzani, interested in the question of spontaneous generation, others interested in questions of fermentation and putrefaction—were led to make experiments which caused them to associate the chemical changes occurring in putrefying and fermenting materials with the presence of living organisms. The next great step was to show beyond all doubt that these living organisms were not only present in the processes of putrefaction and fermentation, but were the *cause* of these processes; this was established by the work of Schwann, Cagniard Latour, Pasteur, and others.

Side by side with these investigations went the examination of animals and human beings dead from various diseases. Micro-organisms similar to those present in putrefaction were found in their bodies. Gradually the idea advanced that these organisms were present not simply as the *result* of the disease, but that they were the *cause* of it. Henle propounded this idea quite plainly in 1840, and the discovery of the fungi of ringworm and the acarus of itch, and the study of certain diseases of plants, gave great support to this view. Semmelweiss, of Vienna, in 1847 came to the conclusion that puerperal fever was caused by the introduction of organic ferments into the genital tract, and he anticipated modern antiseptic practice, with most excellent results, by requiring the students in his wards to wash their hands in chlorine water before making a vaginal examination.

Absolute proof that the micro-organisms and not some chemical substances associated with them were the all-important factors in disease could not be furnished until it was found possible to grow the organisms outside the animal body. This was first done in the case of anthrax or wool-sorters' disease. In 1850 the French observer Davaine saw and described bacilli in the blood of animals dying of anthrax, but it was not until ten years later that he suggested that the bacilli which he had seen were the cause of the disease. Davaine spent many years in a vain endeavour to prove this, but it was not until 1875, when Koch grew the anthrax bacillus upon artificial media for several generations, and thus freed the microbe from all material derived from the animal from which the bacillus was originally derived, and further showed that this purified organism would, if injected into an animal, produce the disease, that the great controversy was set at rest, and it was admitted that a micro-organism was the cause of this disease.

From this time onwards similar proof has been obtained with regard to other diseases, such as tuberculosis, glanders, cholera, and enteric fever, and now the assertion that an organism is the cause of the disease in which it is found meets with no opposition. There is indeed too great a tendency to accept the mere presence of an organism in a diseased tissue as proof that this organism is the cause of the disease, for it must be remembered that before such an assertion can be accepted the same kind of evidence that was required in the case of anthrax must be obtained. It must be shown that an organism of definite characters is constantly present in a disease; it must be further shown that this organism can be separated and grown on artificial media; and finally it must be shown that it can, when inoculated, give rise to a disease similar in all respects to that from which the microbe was originally obtained. These requirements are known as "Koch's postulates." It has been found very difficult in some cases to infect the lower animals with human disease, but this gap in the proof has been filled by the voluntary or accidental inoculation of workers in bacteriological laboratories.

Traces of the history of the investigations which led to the present views on infection are to be found in the nomenclature of disease. From the similarity existing between infectious diseases and the phenomena of fermentation set up by organised ferments, such diseases (scarlet fever, measles, etc.) were spoken of as **zymotic**, from the Greek word meaning to ferment. Many cases of wound-infection, puerperal fever, and allied disorders were connected with infection by putrefying material, and such diseases were called "septic" (*sepsis*, decay or rottenness). When it was shown that the dangerous nature of this decaying material was due to the organisms found therein, the term "sepsis" became restricted to infection by pathogenic organisms. Thus a septic disease is one due to the presence of micro-organisms, and in a septicæmia bacteria are present in the blood.

The facts with regard to wound-infection were further investigated by many surgeons, chief among whom was Lord Lister, and methods for avoiding the ill effects of such infection were developed. **Antiseptic surgery** seeks, by chemical means chiefly, to render the wound and everything brought into contact with the wound unfavourable to the existence, or at least to the growth, of infectious organisms. **Aseptic surgery,** on the other hand, attempts to prevent all access of organisms to a wound by allowing nothing containing bacteria to come into contact with it, whether it be instruments, dressings, or the surgeon's hands.

II.—BACTERIA OR SCHIZOPHYTES

The organisms to which so many infectious diseases are due are very small vegetable cells which find their nearest relatives in the plant world amongst the moulds and fungi. Each cell is a complete organism in itself, and though there is often an arrangement of cells into groups, yet, unlike what occurs in the higher plants, the single cell never loses its capacity for leading a complete life. In shape these cells are either little spheres (*cocci*) or little cylinders. These latter are either straight (*bacilli*) or corkscrew-shaped (*spirilla*). These forms, and the way in which the individual cells are grouped, are the basis of classification.

Cocci.—The organisms which consist of spherical cells like a billiard-ball are called *cocci*, and from their small size *micrococci*. When the spheres are arranged in pairs they are called *diplococci;* when in long chains like beads of a necklace, *streptococci*. When the grouping is irregular, and the organisms form small grape-like bunches, they are called *staphylococci*, and it is one of these organisms which is so commonly found in the pus of wounds.

Bacilli.—The organisms whose cells are shaped like little straight cylinders are known as *bacilli*. The diameter of an organism is very constant, but the length of the cylinder may vary very much. In this group also cells may be paired or in chains, and these forms are known as *diplobacilli* and *streptobacilli*.

Spirilla.—The organisms with cylindrical cells bent into corkscrew shape are known as *spirilla*. These organisms are also met with as segments of the complete spiral, and are then known as *vibrios* and *comma bacilli*. Thus the *Spirillum choleræ* discovered by Koch is often spoken of as the comma bacillus, as it is generally found in the fæces as a short comma-like organism, which on cultivation grows into typical spirals.

Size and rapid multiplication.—Two of the most striking characters of bacteria are their very minute size and their extraordinary powers of rapid multiplication. Their size is such that it would require 10,000 to 15,000 bacilli placed end to end to stretch an inch, and within a single white cell of the blood there may be found from 50 to 100 micrococci. Their rapidity of growth is so great that, as has been calculated by Cohn, from a single organism there could be produced in three days, provided that nothing hindered their multiplication, a mass of living organisms weighing 7,300 tons and numbering 4,772 billions of germs! The importance of not permitting the entrance into a wound of a single living microbe is thus seen.

Method of multiplication.—The method by which bacteria multiply is by division of the cells. Each sphere or cylinder divides into two spheres or cylinders, and these grow until each of the daughter-cells is as large as the original mother-cell which gave rise to them. Each of the daughter-cells then divides so that four cells are produced. The next division results in eight cells, and so on. If the original cell divides at such a rate that the two daughter-cells are formed in half an hour, then if this rate of division be continued for 24 hours the original single cell would have given rise in that time to 17 millions!

Spores.—Some bacteria, and amongst them some of the pathogenic bacteria, form bodies called "spores," which are to some extent similar to the seeds of plants. These "spores" are much more resistant to destructive agents than are the cells in which they are formed. The "spores" are usually spherical or oval bodies, surrounded by a thick double membrane to which in part their resistance is due. The most important properties of spores are, first, their power of resistance, and secondly, the capacity which they possess of being able to grow (like the seeds of a plant) into cells exactly similar to those in which they were formed, and endowed with the capacity for multiplication which has been described. If a spore escapes destruction and gains access to materials in which it can grow, then in a short time millions of organisms may be present.

Fortunately, the majority of the organisms met with in disease and liable to infect wounds are non-spore-bearing. The most important spore-forming pathogenic bacilli are *Bacillus anthracis*, *Bacillus tetani*, and *Bacillus œdematis maligni.*

Motility.—Amongst the bacilli and spirilla there are many which are actively motile. In the living state it is impossible to see by what means the organism moves, but when stained by special methods it is found that these motile organisms possess long hair-like processes called "flagella." These flagella are situated sometimes at the ends of the cells, and sometimes all round, so that from their appearance these latter cells have been called "spider-cells."

Distribution.—Micro-organisms are so widely distributed that they may be truly said to be omnipresent. They are found on the surface of all objects, living or dead, and are present in air, soil, and water. A large proportion of these bacteria are harmless, and in some cases useful, but though the harmful bacteria are present in smaller number they have an almost equally wide distribution. It must be borne in mind that cases of infectious disease form a continuous and practically unbroken series; each case is derived directly or indirectly from a preceding case. In some instances the infectious agent is transmitted directly from patient to patient, while in other cases the infectious material may have escaped into the outside world, and may only return to man and produce its bad effects after a prolonged existence in water, soil, or food. This means that, in the majority of cases, harmful bacteria found in the air, soil, water, and food are due to the presence of the discharges from cases of infectious disease. It is therefore all-important for the effectual arrest of a disease that all discharges, whether from the skin-surface, from wounds, or from the respiratory, intestinal, or urinary tracts, shall be at once sterilised and not permitted, while still containing the dangerous micro-organism, to escape into the outer world, to return in the form of dangerous dust, or dangerous water or food. In the section dealing with the commoner pathogenic organisms the chief sources of danger will be indicated, but a few general considerations relating to air, soil, and water will here be given.

The air.—In the early days of antiseptic surgery the air was regarded as a source of great danger, and steam sprays and other devices were used to prevent organisms falling into wounds from the air of the operating-theatre and ward.

Reasonably pure air contains only some 5–10 organisms per litre, and these are mostly harmless. Flügge calculates that, accepting an average of 100 bacteria per cubic metre, a man will in 70 years inspire about 25,000,000 bacteria, or about as many as are contained in rather less than a pint of fresh milk. Organisms in air have no food to live on, and are exposed to sunlight and oxidation. The danger of air lies in the dust that it carries. A grain of dust may contain millions of bacteria. Tyndall showed that dust-free air was also bacteria-free air. Hence efforts should be directed to secure the absence of all dust. The air of some situations, such as sewers and slaughter-houses, is much more free from bacteria than would be expected, and this freedom is due to the fact that the walls of sewers are moist, and the floors and buildings used for slaughter-houses are flooded with water, so that the bacteria stick to these moist surfaces, and there is no source of dust. Dry dusting should therefore be replaced, where possible, by wiping with damp cloths, and the walls and floors of operating-theatres kept moist. Currents of air of even considerable velocity fail to detach bacteria from moist surfaces and moist materials.

Though large numbers of bacteria are inspired, these in health do not pass beyond the moist surface of the nasal and buccal cavities; and the expired air is practically free from organisms, and therefore the breath of a patient need not be feared. This does not hold when coughing or other similar violent respiratory efforts occur, as in this case there is a discharge of particles of sputum and droplets of saliva into the surrounding air, and these may carry the infectious agent.

Anthrax is one of the diseases which are carried by the air. The spores of the organism are discharged with the dust produced in unpacking bales of infected wool, and are sometimes inhaled, though the disease is more usually spread by inoculation of wounds.

The **soil** is a very important source of micro-organisms, as it is constantly receiving the dejecta of men and animals, which teem with organisms. Because it provides such suitable conditions for the multiplication of these organisms the upper layers are full of bacteria, and these upper layers are the source of the dust which renders the air dangerous. The soil contains harmful organisms derived from the excretions of sick people, but it also contains others derived from the evacuations of healthy men and animals, which, when they are inoculated in certain ways, will produce disease. Thus the intestine of the horse harbours the bacillus of tetanus and of malignant œdema, and the human intestine contains the *Bacillus enteritidis sporogenes.* It is the presence of these organisms, all of them spore-bearing, which renders wounds and compound fractures caused by street accidents so dangerous when the mud of the roads is driven into the damaged tissues. Hence, too, it is desirable that boots should be changed before entering a ward or operating-theatre, and the mud which so often sticks to ladies' skirts is a source of danger.

Water may contain all the bacteria which can be washed out of the soil, but, fortunately, many of the harmful soil-bacteria do not find in water a very suitable medium for growth, and die out. It is a source of considerable danger to man, however, because it is used so largely for drinking and other domestic purposes. But these dangers concern more the hygienist than the nurse.

The **human body** itself, apart from all question of disease, is one of the greatest sources of harmful organisms. The surface of the healthy body, and particularly places which are moist and warm, such as the axillæ and groin, are peopled by numerous pathogenic organisms, especially such as produce suppuration. The cavities of the body, the mouth, nose, and others, are full of organisms, many of which are harmful. In the saliva of healthy people the pneumococcus is commonly found, and the *Bacillus diphtheriæ* is not uncommon in the throats of nurses in attendance on diphtheria patients. In operations the chief risk, apart from the opening of a focus of suppuration, lies in the skin of the patient, surgeon, and assistants. In disease the excreta from the lungs, intestine, and kidney may contain the specific bacterium causing the disease, and are therefore dangerous. The degree of danger possessed by these excreta varies in different diseases, and will be mentioned in the chapter dealing with the individual organisms.

What has just been said with regard to the human body in a state of health being a source of bacteria refers entirely to the external surface of the body. It is a fact of fundamental importance that the tissues and secretions of a healthy individual are sterile. The blood, the kidneys and ureters, the bladder and the urine, the liver, gall-bladder and bile-ducts, the acini of the lungs, the milk-ducts and milk, are all sterile in the healthy person, and only contain bacteria when these have penetrated from without.

Entrance of bacteria into the body.—It must be clearly understood that all infection proceeds from without, and the infectious agent has to gain access to the body and penetrate into the lymph, blood, or tissues before it produces its effect. Bacteria may penetrate either through the skin or from the intestine or the air-passages. To the physician the most important channels of infection are the intestine and the air-passages; to the surgeon, the skin.

Fortunately, the uninjured *skin* and the intact lining *membranes* of the intestine and respiratory tract are very efficient barriers against the entrance of bacteria. It has been shown to be possible to force organisms deeply into the skin, especially at the sites of the sweat glands and hair follicles, and boils and carbuncles nearly always occur where constant friction of the clothes rubs the infecting organism into the skin.

Though infection through intact skin and mucous membrane is possible, yet it is unusual, and it is quite certain that all wounds and abrasions of the skin and of the lining of the intestine make it much easier for the bacterium to penetrate. Unfortunately, small lesions of the skin are very common, and the objects which cause the injuries, such as knives, thorns, nails, often carry the harmful germ. The bacteria which usually infect through food and gain entrance from the intestine are generally capable of injuring and causing shedding of the protecting epithelial cells of the bowel. In some cases one disease may prepare the entrance for the bacteria of another ailment. Thus the infectious fevers, measles, and scarlet fever cause loss of epithelium of the air passages, and so pave the way for the easy penetration of the tubercle bacillus.

There is one mode of skin-penetration the full importance of which has only recently been suspected, and that is by the bites of insects. This method is probably of greater importance in the tropics than in temperate regions, but even in these regions it may be more important than is generally thought. Malaria and yellow fever are spread by the bites of mosquitoes, sleeping sickness by an African fly (*Glossina palpalis*), a form of relapsing fever by a tick, and plague by the parasites of the rat. A number of cattle diseases are spread in the same way.

Infection by the *lungs* only takes place when the organisms are inhaled; and the importance of infected dust has already been considered.

Infection by the *intestine* is usually due to the use of infected food. Food may be dangerous for two reasons. Infectious material from a human or animal source may gain access to food which was originally sound and render it dangerous, or it may be harmful because obtained from a diseased animal. Milk supplies a good example of this twofold source of infection. Perfectly good milk may be contaminated with the typhoid bacillus because bad water has been used for washing out the vessels in which the milk is contained, or for adulteration. On the other hand, the milk may have been dangerous from the first because the cow which produced it was suffering from tubercle of the udder, and excreted the *Bacillus tuberculosis* with the milk.

The means by which food becomes infected is sometimes very circuitous. In hot countries, dust plays an important part in enteric fever and cholera, and flies are far from unimportant. In these islands it is a matter of great importance that the access of flies to food, and especially to milk, should be prevented. The contamination of milk by flies plays an important part in the extremely fatal "summer diarrhœa" of infants.

In India the prevalence of typhoid fever in the Army has been connected with the use, for the purpose of cleaning the food vessels and pans, of earth infected by convalescent, but still dangerous, cases.

III.—PATHOGENIC BACTERIA AND THEIR PRODUCTS

(Frontispiece and Plate xxv.)

Only such organisms as are of common occurrence in medical and surgical practice will be described here, and attention will be directed only to such characters as are of practical importance to the nurse. The bacteria of primary importance in surgical cases are those producing suppuration, and these will be described first.

1. **Staphylococcus pyogenes aureus.**—This is the commonest organism met with in suppuration. It is a micrococcus occurring in groups, and produces a yellow pigment in culture. It is non-motile and does not form spores. It is found in the pus of boils, carbuncles, abscesses, and in periostitis, osteomyelitis, and the general septicæmias which result from these diseases. It is also found in the healthy person in the mouth, alimentary canal, under the nails, in the eyes, nose, and ears, in the superficial layers of the skin, and is distributed in water, soil, and air. It has been found in the dust of surgical wards. It is quickly killed by 1-20 carbolic acid, by 1-1,000 corrosive sublimate, and by a few minutes' boiling.

Danger of infection arises from the pus, and, in operations, from the hands and other parts of the body of the surgeon and nurses.

Varieties of this organism are met with under the names of *Staphylococcus pyogenes albus* and *Staphylococcus epidermidis albus.* The latter is decidedly less virulent than the other varieties, and is met with constantly in the skin.

2. **Streptococcus pyogenes** is an organism forming long chains of spherical cells; it does not form spores. It is found in the pus of abscesses, but its characteristic property is the production of spreading inflammations such as cellulitis and erysipelas. Sometimes it is called *Streptococcus erysipelatosus.* It is found in the blood in puerperal fever and in ulcerative endocarditis, and occurs in peritonitis and empyema. It also is widely spread in the cavities and secretions of the healthy body. The dangers of infection are of the same nature as in the case of that organism, and it is killed with equal ease.

3. **Bacillus coli communis** is a small motile, non-spore-bearing bacillus found constantly in the intestines of the normal individual, and usually harmless, but capable of becoming dangerous and producing suppuration. It is found in cases of peritonitis. It is also capable of rendering milk

dangerous, and probably occasionally produces diarrhœa, especially in children.

4. **Bacillus tuberculosis** is a small non-motile bacillus which does not form spores. It is, however, more resistant to heat and disinfectants than most non-spore-bearing organisms. Boiling for some minutes is required to kill the bacillus. It is found in enormous numbers in the sputum of patients with phthisis, and in the pus from all tuberculous abscesses, as well as in tuberculous deposits.

The *danger of infection* lies in the *sputum* of phthisical patients, though, of course, all tuberculous discharges which contain the bacillus are dangerous. The sputum may contain as many as four billion bacilli in the twenty-four hours, and these bacilli are still virulent after five months in dust-dry sputum. They are virulent, too, after six weeks in putrefying sputum. The sputum is chiefly dangerous in the dried state, because in this condition it is more readily converted into dust, and thus disseminated in the air and inhaled. Sputum on the floor of rooms is dangerous, as young children crawling about the floor convey it into their mouths. Phthisical patients in speaking and coughing project particles of infectious sputum into the air, but these particles, though they float for some time, are rarely found more than a few feet from the patient.

Sputum should always be received into vessels filled one-third full of a mixture of lysol and soap. The contents of these vessels can be boiled in water containing soda for half an hour, and then poured down the drain. Re-infection of the patient and danger to others arise from spitting into handkerchiefs instead of into cups containing a disinfectant, and the pockets into which the soiled handkerchiefs are put are a source of danger, as they become highly contaminated.

Many cases of human disease are caused by drinking contaminated *milk*. This is a very real danger, as it has been shown that as many as 19 per cent. of the samples taken of the milk supplied to towns contain the *Bacillus tuberculosis.* The only precaution that is possible in the home is to boil the milk. If it be put into the usual double saucepan with *cold* water in the outer vessel, and brought to the boil, and maintained at that temperature for four minutes, the milk will be safe. If the lid of the inner vessel be kept on, and the milk after boiling be rapidly cooled by placing in cold water, there will be very little flavour of cooking and no scum.

5. **Diplococcus pneumoniæ** is non-motile and does not form spores. It is found in the sputum of pneumonic patients and is the cause of croupous pneumonia. It is capable of producing suppuration, and is found in the pus in suppuration of the middle ear, meningitis, empyema, and suppuration of joints. Infection in pneumonia is rare. The pus containing the organism is dangerous.

6. **Bacillus tetani** is a motile, spore-forming bacillus which only grows under anaërobic conditions of culture. Its spores are spherical and situated at one end of the bacillus, so that the organism looks like a drumstick. Though the organism may be found in the pus of a wound causing tetanus, there is little danger of infection from this source. The bacillus is found in manured soil, and wounds inoculated with such soil are liable to cause tetanus. The spores are difficult to destroy either by heat or disinfectants. 1-20 carbolic with ½ per cent. hydrochloric acid is one of the best antiseptics to use.

There are other spore-bearing anaërobic organisms in manured soil, which are apt to cause serious spreading gangrene if inoculated in a wound.

7. **Bacillus diphtheriæ**, a non-motile, non-spore-forming organism, found in the false membranes of diphtheria, wherever those membranes may be formed. It is about the same size as, but thicker than, *Bacillus tuberculosis*.

The *danger of infection* lies in the false membrane, in the discharges from the nose and fauces, and in the use of feeding-vessels and other articles used by a patient suffering from the disease. The bacillus will remain alive for three months in dried false membrane.

8. **Bacillus mallei.**—This is the bacillus of glanders, and resembles in size and shape the tubercle bacillus. It is non-motile and does not form spores.

The *danger of infection* lies in the discharges from the suppurating nasal mucous membrane, and from the lungs if they are attacked. The pus from the skin eruptions and abscesses which occur in the disease is also highly dangerous. The same temperature and the same strengths of antiseptics which kill *Staphylococcus aureus* will kill the glanders bacillus. Infection usually takes place through wounds of the skin or inoculation of the nasal mucous membrane.

9. **Bacillus typhosus** is the cause of enteric fever. It is a motile, non-spore-bearing bacillus found in the fæces and urine as well as in the

blood and internal organs of typhoid patients. It can live in water and in soil. The dangerous discharges in this disease are the fæces and urine. It is especially necessary to guard against infection by the urine, a source of danger which was not recognised until recently. Moreover, the urine retains its infective characters for a long time, and occasionally even after convalescence is complete.

10. **Spirillum choleræ.**—The cause of Asiatic cholera. A small, motile, non-spore-bearing organism found in the intestinal discharges of patients. The fæces are the source of danger in this disease, and infection may remain even when the patient is convalescent.

11. **Bacillus pestis.**—The bacillus of plague. A small short non-motile, non-spore-bearing bacillus found in the pus of the buboes characteristic of the disease, and in some cases in the sputum. These latter cases are especially dangerous. The disease appears to be transmitted by the inoculation of wounds, by infection of the respiratory tract, and by the bites of the parasites of the rat, which is itself a victim of plague. It is especially necessary in this disease to prevent the access of flies and other insects to any infectious secretion, lest they carry the disease by their bites.

12. **Bacillus anthracis**, the cause of anthrax, wool-sorters' disease, or splenic fever. A comparatively large non-motile, spore-bearing bacillus. It is found in enormous numbers in the blood of the patient.

This is a disease incident to certain trades and occupations, and is rarely if ever transmitted from one patient to another, but the discharge from the malignant pustule of man is dangerous.

13. **Micrococcus gonorrhœæ.**—This organism is a diplococcus, not spore-bearing nor motile. It is found in the genital tract, and is very liable to infect the conjunctiva. The secretions from both the urethra the conjunctiva are highly infectious.

Various explanations have been given as to the way in which bacteria produce the symptoms of the diseases in which they are found. It is now generally admitted, however, that they act by means of poisonous materials which they produce. The principal bodies which result from the growth of pathogenic bacteria are pigments, ferments, and poisons.

Pigments.—Many organisms which cause disease, and still more frequently the bacteria met with in air and water, produce brilliant yellow, red, violet, and green pigments. One of the commonest organisms

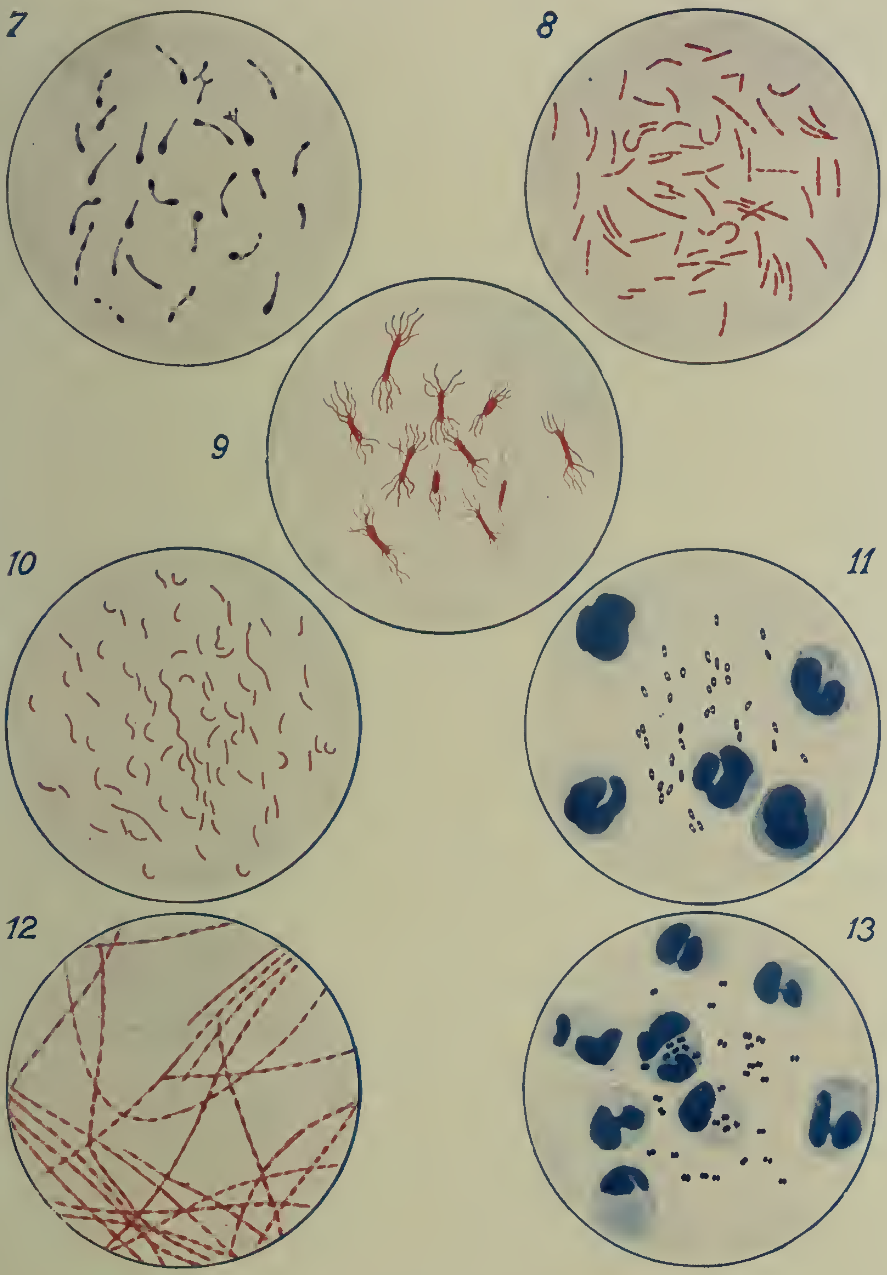

PLATE XXV.—PATHOGENIC BACTERIA. *(See also Frontispiece.)*

7. BACILLUS DIPHTHERIÆ 8, BACILLUS MALLEI. 9, BACILLUS TYPHOSUS. 10, SPIRILLUM CHOLERÆ.
11. BACILLUS PESTIS 12, BACILLUS ANTHRACIS. 13, MICROCOCCUS GONORRHŒÆ.

found in pus, the *Staphylococcus pyogenes aureus*, produces a golden yellow pigment, and the *Bacillus pyocyaneus*, or bacillus of blue pus, is so named from its sky-blue pigment.

These pigments, apart from their intrinsic interest, are of importance in that they help to distinguish one organism from another, and in that they furnish a striking demonstration of the way in which a physiological property—in this case colour-production—may be aided or arrested by changes in the material upon which the organism is growing, or by changes in the conditions of temperature, light, and access of oxygen to which the organism is exposed. Thus a pigment-forming organism such as *Bacillus prodigiosus* may be robbed of its colour-producing power by growing it under special conditions, and, what is still more important, a race of bacilli may be produced from the red *Bacillus prodigiosus* which, unaltered in other respects, has permanently lost its power of producing pigment.

An organism, then, may have its physiological properties altered by artificial selection or by changes in its environment; and this applies to the power of producing poisons as well as to the power of producing pigments.

Ferments.—These are chemical bodies produced by bacteria, by means of which changes in various substances, such as sugars, fats, and proteids, are brought about. Each ferment produces its own particular chemical action. Some cause coagulation of milk, some—like pepsin—digest and liquefy albumen and other proteids, and others act upon fat.

Toxins.—To the patient, however, the most important products of the life of the bacteria are poisons. The specific poisons, those by which the symptoms of a disease are produced, are built up by the micro-organism from the food-material with which it is supplied. At one time it was thought that they were formed by the decomposition of the material in which the organism is growing, just as alcohol is formed from sugar by the yeast plant. Poisonous bodies undoubtedly may be formed in this way, but they are not the specific poisons. The most important group of poisons thus formed from proteids are the ptomaines, which are sometimes supposed to cause epidemics of food-poisoning.

The best-known specific poisons, none of which has been obtained in the pure state or has been analysed chemically, are those of tetanus and diphtheria. These are extremely active bodies, producing effects in infinitesimally small doses, much smaller than the fatal doses of opium, aconite, and other similar poisons. They are rather easily destroyed by heating (under 212° F.), and lose their power when kept if exposed to the action of air and sunlight.

One very important difference between the poisons produced by certain organisms is to be noted. If cultures of a series of different varieties of bacteria be made upon fluid media, it is found that when these cultures are filtered so as entirely to remove the organism (*see* p. 77), some of the filtrates are very highly poisonous—such as those of *Bacillus diphtheriæ* and *Bacillus tetani*—and others are not poisonous at all, or only to a very small extent.

Some organisms, then, **excrete** their poisons; these poisons are consequently found in the medium of growth, and can be separated by filtration, and are called *ectotoxins*. The other group **secrete** their poisons, which remain within the body of the organism that produces them, and are called *endotoxins;* these do not pass into the filtrate.

Corresponding with this difference in the relations of the poisons to the microbes which produce them, these two groups of bacteria are found to behave very differently in the tissues of any animal to which they gain access. Thus, in a case of diphtheria, whose bacillus produces an excreted toxin, the only part of the body (broadly speaking) in which *Bacillus diphtheriæ* is found is the false membrane, wherever that may be produced. In the same way, in tetanus the bacillus is confined to the wound which causes the disease. The symptoms are produced by the excreted poisons, which are absorbed by the patient. Such diseases as these are spoken of as *toxic diseases.*

On the other hand, if a case of tuberculosis be examined, the lungs and probably many other organs are full of "tubercles" or small growths, and in each of these the tubercle bacillus will be found. In this disease, where the organism produces an endotoxin, the bacillus "infects" the body, and is to be found wherever there is evidence that a toxin has been produced. The poison within the body of the microbe acts at a small distance, so that where there is damage to the tissue, there the microbe is to be found. Diseases of this latter type are called *infectious diseases*, and in this group are included tuberculosis, anthrax, glanders, etc.

Two important consequences flow from this difference in the mode of action of the two groups of organisms.

The first consequence is, that while in the toxic diseases the only materials dangerous to a healthy person are derived from the local situation in which the micro-organism is to be found—*e.g.* the false membrane in diphtheria, or the pus of the wound in tetanus—in the infectious diseases nearly every part of the body of the infected subject, blood, internal organs, and all the excreta, may contain the micro-organism, and be consequently dangerous to others, and require careful disinfection.

The second consequence is that, as will be explained later, in the toxic diseases, if the poison be neutralised by any means, the organism is rendered practically harmless, whereas in the infectious diseases it is necessary to kill the micro-organism, and simple neutralisation of the toxin does not suffice.

IV.—VACCINES AND ANTITOXINS

It is an old-established fact within everyone's experience that one attack of some diseases, especially one of the infectious fevers, practically prevents a second attack of the same disease. When investigators had the active cause of an infectious disease in their hands, and were able so to alter its characters as to make it lose its extreme virulence and become "attenuated," it was natural that they should try whether an animal which was inoculated with this modified or attenuated organism would be protected against any further attack of the disease, in the same way that a child inoculated with small-pox vaccine—vaccinated—is rendered insusceptible to an attack of small-pox.

Experiment soon settled that this was the case. The most conspicuous example of such protective inoculation was obtained in the case of anthrax, which causes the deaths of large numbers of sheep and oxen annually. The "vaccine" used in the case of anthrax is a living culture of the anthrax bacillus, modified by growing it above 108° F. for ten to twenty days. It is to be noted that the animal is injected with the living bacillus, suffers from a slight attack of anthrax, and on recovery is found to be insusceptible to a second inoculation and incapable of being infected when returned to a herd of animals suffering from the disease. Such an animal is spoken of as "protected" or "immunised," and the process by which the protection is secured is, on account of the analogy with small-pox, spoken of as "vaccination."

Further experience showed that in certain cases, and notably in diphtheria and tetanus, animals could be protected or vaccinated by means of the chemical products of the organisms, *i.e.* by filtered cultures or by cultures sterilised by heat. It is probable that in Pasteur's method of treatment for rabies the protecting material employed belongs to this group.

Protection, then, may be secured by the "vaccination" of animals (including man) (*a*) with living organisms whose virulence has been modified or whose effects are kept in control by the smallness of the dose used; (*b*) with the modified or unmodified chemical products of the organisms which are the cause of the disease against which protection is sought.

VACCINES

The principal "vaccines" which are employed in medical practice are the following:—

Small-pox vaccine.—This is the vaccine which gives its name to the entire group of protecting materials, and which has been employed since Jenner's discovery in 1796. The vaccine is the prepared scrapings of vesicles produced in the calf by the inoculation into that animal of material from a case of "vaccinia" (or cow-pox), or of material from a case of small-pox in man. It has been conclusively shown that vaccinia in the cow owes its origin to a virus identical with that which produces small-pox in man.

Anthrax vaccine is employed only in the case of animals. It is a living culture of *Bacillus anthracis*, whose virulence has been reduced by prolonged growth above 108° F.

Typhoid vaccine is a sterilised culture of *Bacillus typhosus*. Two vaccinations are usual at an interval of ten to fourteen days.

Cholera vaccine (Haffkine).—The vaccines used are prepared from cultures of the spirillum, which are grown under special conditions in order to make the first vaccine used of slight virulence, while the culture used for the second vaccine is of increased virulence.

Rabies vaccine.—This is an emulsion of the spinal cord of a rabbit which has been inoculated with rabic virus of definite strength. The spinal cord is kept at 77° F. in a dry condition for three to fourteen days. The longer the time of drying, the less the potency of the emulsion made from the spinal cord.

Plague vaccine (Haffkine).—This is a sterilised culture of the plague bacillus (*Bacillus pestis*). It has been used very extensively and with good results in India.

Tubercle vaccines.—There are several forms of these. The best known are Koch's "tuberculins." These are in all cases extracts of the tubercle bacillus, obtained in various ways. In animals emulsions of living tubercle bacilli have been employed, and sterilised emulsions have been used in man.

ANTITOXINS

When Behring, Ehrlich, and other experimenters examined into the cause of the protection secured by these vaccinations in the case of diphtheria and tetanus, and some other diseases, they found that the blood serum of the protected animals had become modified, and contained bodies which did not exist there before the vaccinations. These new bodies were capable of neutralising and rendering harmless the toxins used in the process of protection. They were therefore called *antitoxins*, and the serum which contained them *antitoxic serum*.

The further discovery of vital importance was also made, that if these antitoxic serums were injected subcutaneously into an animal, that animal became protected against the deadly effects of the micro-organisms or their poisons.

A discovery of almost equal importance was that this protection followed the injection of antitoxic serum *at once*, and that it could be used to combat a disease which had already laid hold of a patient.

There is, then, a third way in which animals may be protected, viz., by the injection of the blood serum of an animal which has been "vaccinated," and in which, as a consequence of the process, antitoxins have been developed.

A certain number of therapeutic serums are used in practice, amongst which by far the most important is **Diphtheria antitoxic serum**, or diphtheria antitoxin. Others are Tetanus antitoxin, Snake-venom antitoxin, Plague antitoxin (Yersin), Tubercle antitoxin (? Marmorek), Antipneumonic serum, and Antistreptococcic serum.

In certain diseases the serum of the protected animal did not contain bodies quite similar to those occurring in diphtheria and tetanus, but other bodies which under certain conditions were capable of destroying bacteria of the variety which had been used in the process of vaccination. The two last-mentioned serums in the list probably belong to this group of antimicrobic or bactericidal serums.

Diphtheria antitoxic serum is so much used that a short description of the process by which it is obtained may be of interest. A powerful poison is in the first place produced by growing in a fluid medium the diphtheria bacillus obtained from the human throat. After about nine days' growth this culture is filtered through a Berkefeld filter, and in the filtrate is the poison. This poison is injected into a horse at the point of the shoulder. The horse before being used is tested with tuberculin and mallein, to make sure that it is free from tubercle and glanders. Very small doses are used at first for injection, and are gradually increased until after some months the horse can stand enormous doses of poison, often more than a thousand times that which would have sufficed to kill in the first instance. The blood of the animal now contains the antitoxin. The horse is bled from its external jugular, and the blood received into sterile vessels, allowed to clot, and the serum decanted and filtered. This filtered serum, distributed into bottles and treated with a small quantity of antiseptic, is the antitoxic serum employed for injection. Before it is sent out its strength is tested, and the strength, *i.e.* its power of neutralising diphtheria toxin, is stated in units.

Agglutinating bodies, bactericidal bodies, and opsonins.—Other bodies also appear in the serum as the result of disease or of artificial protection by vaccines. The three most prominent are agglutinating bodies, bactericidal bodies, and opsonins. *Agglutinating bodies* cause bacteria of the same kind as that used in the "vaccination" to clump together or agglutinate when some of the serum of the patient or protected animal is mixed with a culture of the bacillus. Thus, if the serum of a typhoid case be mixed with a culture of *Bacillus typhosus*, this latter will clump or agglutinate. This constitutes the well-known Widal's reaction, used as a diagnostic test for typhoid.

Bactericidal bodies are bodies which, in conjunction with a material present in normal blood serum, cause destruction of bacteria.

Opsonins are bodies which render a bacterium more easy of ingestion by the white blood cell or phagocyte.

Immunity.—One of the most important facts to be borne in mind is that though, as we have seen, we are constantly in contact with disease germs, we fortunately rarely become infected. In the great majority of cases this is due to the fact that the harmful germ never gains access to our body—thanks to the skin and the mucous membranes, and to the destructive action of various secretions such as the gastric juice. The infecting organism, too, requires various conditions before it can produce its harmful effect. It requires to gain entrance to the body by certain channels; thus the tetanus bacillus is practically harmless if swallowed, but dangerous if introduced by a punctured wound. The bacterium must be in an active condition, and not, as is often the case, enfeebled by the action of sunlight and air. Some organisms require help from others before they are dangerous, and others are helped by any damage caused by violence, or by the action of chemical agents, or by the processes of inflammation, however set up.

Much may be done, therefore, to prevent disease by avoiding all the factors which facilitate the entrance or assist the growth of the infecting microbe, and very much also, as has been shown, by preventing the dissemination of infectious material from the sick person in the outer world, and so diminishing the risks of infection.

But, besides the general immunity due to such factors as are considered above, it is found that even when the organism is present, and the conditions are entirely favourable to its action, still the disease may not develop. Algerian sheep cannot be infected with anthrax; the mouse cannot be killed with diphtheria poison; and some races of men are not affected by certain diseases which are highly dangerous to other races. Such animals and men are said to be *naturally immune*. But, as has been shown above, animals and men may be rendered artificially immune by various vaccines and protective serums; and in some cases, at any rate, this condition seems to be consequent on the appearance in the blood of protective bodies which either kill the microbes or neutralise their poisons.

In addition it has been shown, principally by Metchnikoff, that the body possesses in its leucocytes or white blood cells an army capable of being enrolled for the defence of the body against the invading micro-organism—an army which is not always victorious, and which, like other armies, is less likely to be successful if it is not kept in a high state of efficiency. Good food, proper exercise, fresh air, are all-important agents in keeping up the efficiency of the phagocytic army, and the processes of vaccination detailed above are processes by which the white cell is educated to meet its enemies. Whatever theory we may adopt as to the exact mechanism by which immunity is produced, it is certain that the healthier the body, and the healthier the conditions of life, the less likely is infection to occur, and the less will be the consequences if an organism does gain entrance to the body. It is in the power of the nurse to aid very materially in securing these desirable conditions.

V.—CULTIVATION OF BACTERIA

There are in Nature vast armies of bacteria engaged in producing various chemical changes. Amongst their most important functions is the decomposition of dead animal matter—putrefaction—until it is reduced to very simple bodies, such as ammonia, water, and carbonic acid, which easily become suitable for the maintenance of plant-life. These organisms living on dead tissues are called *saprophytes*, and are usually harmless to man, or *non-pathogenic;* they may even be useful to him.

The group of organisms which is capable of growing in the living body (hence called *parasites*) and of producing disease—the *pathogenic* organisms—is fortunately a comparatively small one.

Pathogenic bacteria find in the bodies of animals suitable food and suitable conditions of temperature and moisture to enable them to increase. If similar conditions are supplied outside the body artificially, these bacteria can be grown and cultures of the germs obtained.

The *food* or *culture medium* must contain carbon, nitrogen, oxygen, and hydrogen, certain salts, and sufficient water. It is further found that the pathogenic bacteria like these elements in the form of complex organic bodies, such as albumens, peptones, sugars, and glycerines, and not in the simple form which is suitable for the growth of ordinary plants. Hence liquids such as blood, milk, pleural and ascitic fluid form extremely good media for the growth of bacteria.

CULTURE MEDIA

The most important artificial media used are broth or bouillon, gelatine, and agar-agar.

Broth or bouillon.—This is a solution of extract of meat, made either from fresh meat or from one of the meat extracts (Liebig or Brand), to which are added 1 per cent. peptone and a little salt. It is made slightly alkaline. It is a perfectly clear amber-coloured fluid, and bacteria grow very well in it.

Gelatine medium.—This is broth made to "set" by the addition of 10 per cent. of gelatine. It is a perfectly clear transparent amber jelly, which is solid unless warmed to the temperature of a hot summer's day (77° F.).

Agar-agar medium.—This is broth solidified by adding 2 per cent. of a material derived from seaweed. This material is always opalescent. It remains solid though heated above blood heat.

For some purposes these media may be improved by adding sugar, glycerine, blood, blood serum, or ascitic fluid. The bacillus of influenza and the diplococcus of pneumonia flourish best if blood is smeared on the surface of agar-agar; the tubercle bacillus will not grow unless glycerine and sugar are added, and *Bacillus diphtheriæ* is usually cultivated on a mixture of broth and blood serum, known as Löffler's serum.

If an organism be planted or inoculated upon one of these media, and kept at a suitable temperature in an incubator, it will grow until the originally invisible organism forms a mass of culture consisting of millions of organisms, visible to the naked eye, very often possessed of a characteristic appearance, and not unfrequently coloured.

These cultures are useful in assisting in the recognition of bacteria, and also in detecting bacteria when they are present in such small numbers that they are easily overlooked when sought for under the microscope. Thus, if it is desired to determine whether organisms are present in a ligature, towel, or the skin of the operator, pieces of these materials are dropped into broth or planted on agar. If any organisms are present a culture will be obtained, and be easily recognised, though a direct examination of the materials would probably have failed to reveal any bacteria.

It must be noted that this is a very delicate and severe test, and precautions must be taken that no organisms gain access to the culture fluid save such as may be on the materials being tested.

Temperature of growth.—From the medical and surgical point of view, the temperatures between which organisms can grow and the temperature at which they are killed are of the utmost importance. Saprophytes have a wide range of temperature in which growth is possible, but those which cause disease, and are consequently adapted to growth in the body, have a more limited range from about 60° F. to 115° F., and the temperature at which growth is most rapid is that of the normal body, 98·4° F.

Death temperature.—It is important to remember that outside the range given above the bacteria are not killed, but simply cease to grow. The death of all organisms in the vegetative form (*i.e.* not spores) is caused by prolonged heating (one hour) to 158° F., or by a comparatively short exposure to the temperature of boiling water.

Organisms are not killed by cold; not even by the intense cold produced by liquid air. Freezing arrests the growth of organisms, and therefore preserves foods and other articles, but it does not kill bacteria.

Spores are not killed by simple boiling unless it is prolonged for 30 to 60 minutes, and the most resistant spores are not destroyed until a temperature of 239° F. is reached.

Other conditions affecting growth.—Besides the requisite food, moisture, and temperature, organisms require other conditions for their prolonged life. To some bacteria free oxygen is necessary in order that they may grow (aërobes), while in the case of others (anaërobes) free oxygen is harmful and prevents growth. The most important anaërobes are *Bacillus tetani* and the bacilli which are found in conditions of spreading gangrene. The majority of pathogenic germs are either aërobes or indifferent.

The accumulation of the products of the activity of an organism arrests its further growth, and it is this condition which prevents a culture from increasing indefinitely.

Light, especially direct sunlight, and still more exposure to sun and air, arrest the growth and even kill bacteria. Sunlight and fresh air are two of the best disinfecting agents at our disposal, and the old Italian proverb that "Where the sun does not come there the physician enters" has a solid basis of fact.

VI.—DISINFECTION—STERILISATION

Disinfection is the process by which materials are rendered germ-free. This end may be attained by—

(*a*) *Chemical means*—disinfectants, germicides.
(*b*) *Physical means*—heat and filtration.

Sterilisation is a term usually applied to those processes which render materials germ-free without leaving in the sterilised materials anything which would arrest the growth of micro-organisms. Sterilisation is usually effected by heat, filtration, or the use of volatile disinfectants such as chloroform, which can be easily removed after the organisms have been killed.

ANTISEPTICS

Definition.—An *antiseptic* is a chemical agent which will arrest or retard the growth of a micro-organism. A *disinfectant* or *germicide* is a chemical agent which actually destroys or kills micro-organisms.

In its weaker solutions a disinfectant will act as an antiseptic. The amount of a disinfectant which will prevent growth is very much smaller than that required to kill.

The choice of an **antiseptic** is determined by a number of practical considerations, but there are certain conditions which apply to the efficient use of any of these substances. Such conditions are—

1. **Contact.**—The destruction of an organism is brought about by chemical action between the microbe and the disinfectant, and for this it is necessary that the disinfectant and the organism come into intimate contact. This is often a much more difficult condition to fulfil than is believed. A layer of grease or oily matter on the hands or instruments will prevent contact. Oily solutions of antiseptics are for this reason generally useless, and hence also the value of washings with soap, alcohol, and ether for cleansing the skin before the application of an antiseptic.

It is this difficulty which makes the disinfection of fæces, especially of formed stools, so troublesome, if not impossible. Unless the material is broken down and intimately mixed with the disinfectant, destruction of the organisms is not effected by hours of action. Mixing with sawdust and burning or boiling with water are almost the only efficient means to this end. To sprinkle a stool with disinfectant in the form of a powder is quite inadequate. To sprinkle an antiseptic, unless it be volatile, about a room is also useless.

2. **Time.**—Antiseptics require time for their action to take effect. Mere rinsing an instrument through a disinfecting solution is useless. That this is so often done without harmful results is due to the fact that surgical instruments are generally mechanically well cleaned, and that sufficient antiseptic is carried over into the wound to stop the growth of any germs so introduced. It is this constant presence of an arresting fluid in the wounds and dressings, and on the hands and instruments, in operations done under the antiseptic system, which makes the training of a nurse on this system often a source of danger rather than the reverse when aseptic surgery is attempted, and when there is nothing to prevent disastrous results following the admission of organisms to wounds. Prolonged exposure to a weak solution of a disinfectant is, within limits, equivalent to a shorter exposure to a strong solution.

3. **Amount of antiseptic.**—The amount of work a given quantity of disinfectant can do is limited. In medical and surgical practice the amount of a disinfectant employed is usually adequate, but the quantity

used in attempts to disinfect drains, privies, and such places is very often ludicrously insufficient. It is to be borne in mind, too, that the actual amount of chemical agent in such an antiseptic solution as 1–1,000 mercuric chloride is very small, and may easily be entirely precipitated by soaps, albumen, sulphuretted hydrogen (in putrefaction), and even by a steel instrument left for some time in the solution.

4. **Temperature.**—The efficiency of an antiseptic is increased by a moderate elevation of temperature, being greater at 98° F. than at 54° F.

5. **Composition of the material to be sterilised.**—Many of the secretions which have to be disinfected are good media for the growth of organisms. It is found that the more suitable a material is to act as a culture medium the more difficult does it appear to be to disinfect. Thus, organisms are more easily killed in water than in urine, while urine is more easily disinfected than milk, and milk than blood.

DISINFECTANTS OR GERMICIDES

There are a large number of disinfectants in commerce which are perfectly efficient if properly used, and the choice is determined by the practical considerations of efficiency, rapidity of action, non-poisonous and non-irritating character, cheapness, and freedom from staining and destructive properties. In surgery the first four desiderata are of chief importance, while the last three chiefly affect the choice when the disinfection of rooms and dress materials is required.

A few of the most important chemical bodies in use for disinfecting purposes are considered below, and some of the more important characters of each mentioned.

Mercuric iodide is much employed in medical and surgical practice on account of its convenience and reliable germicidal properties. In many respects it resembles corrosive sublimate, though it is slightly less poisonous and does not precipitate albumin quite so readily. The salt is quite insoluble in pure water, though it freely dissolves, forming almost colourless solutions, if potassium iodide is present in excess. Like corrosive sublimate, it is always desirable to tint its solutions artificially with some anilin dye such as eosin or methylene blue. Some convenient tabloid preparations for rapidly dispensing mercuric iodide are on the market, and if one is added to a pint of water a good disinfectant solution of 1–1,000 strength is instantly ready for use. For cleansing the hands and for irrigation purposes much weaker solutions (1–4,000 or 1–6,000) should always be used. Expense is the practical drawback to the use of mercuric iodide.

Perchloride of mercury or **corrosive sublimate** is one of the most powerful disinfectants known. Its efficiency depends on the property it possesses of precipitating albumin. Freely soluble in water, it forms colourless and odourless solutions, which should always be acidulated and tinted with some anilin dye to render their recognition easier and to prevent the possibility of accident. Unless rendered acid, the salt exercises a marked coagulative effect on albumin, and its use for the efficient disinfection of sputum, excreta, or blood containing pathogenic organisms would be a measure attended with very questionable success.

In both medicine and surgery, corrosive sublimate is extensively employed, and its adoption is now almost universal. For disinfectant purposes a solution of 1–1,000 strength is most satisfactory, whilst dilutions of 1–5,000 and 1–10,000 form good practical antiseptic fluids for douching or for cleansing the hands. Notwithstanding, the use of perchloride is attended by several drawbacks, for it readily corrodes and discolours metals, and, consequently, demands storage in glass or earthenware vessels.

Carbolic acid when pure is a white crystalline body, readily soluble in water, and obtained from coal tar. It possesses a powerful characteristic odour, and as a disinfectant is usually employed in solutions of 1–20 strength.

It is very reliable in its action on micro-organisms, but it irritates and numbs the skin. Surgical instruments do not suffer from prolonged immersion in this fluid, though knives are apt to be deprived of their keen edge. The disinfection of tuberculous sputum is most satisfactorily carried out by a 5 per cent. solution of carbolic acid, the tubercle bacilli being rendered inert in a very short period of time.

Lysol.—This is a very fashionable and efficient germicide, and, like carbolic acid, is obtained from tar oil. When added to water it forms a soapy liquid, and consequently tends to render the fingers rather slippery. In medical and surgical work it is much in favour, and suitable solutions are easily prepared by adding one drachm of the crude disinfectant to a pint of water.

Cyllin.—Under this name a new and very satisfactory disinfectant has been put on the market. It possesses many advantages over the foregoing substances, for, besides being extremely cheap and non-poisonous, it is most efficient from a bacteriological point of view. For irrigation purposes, when delicate mucous surfaces are concerned, a solution of 1–400 strength is most suitable, though for general surgical work a rather stronger solution of 1–200 is desirable. This is simply made up by adding to a pint of water one teaspoonful of the disinfectant. The opaque emulsion that cyllin makes when added to water is a drawback, for instruments immersed for sterilisation cannot readily be seen.

Boric acid, though only a mild and practically non-poisonous antiseptic, is much employed in surgery for irrigating wounds, cleansing cavities, and like purposes. It is also of service in vaginal irrigation, for which purpose a half-saturated solution is usually employed. The crystals dissolve sparingly in water, about 4 per cent. constituting saturation.

Iodine.—Weak solutions of the tincture of iodine are greatly in favour amongst many gynæcologists for vaginal and uterine douching, a drachm to the pint of water forming the strength in common use.

The disinfectants already mentioned are non-volatile, but where it is desired to disinfect rooms in which cases of infectious disease have occurred, a gaseous disinfectant is of much service. The two most commonly employed are—

1. **Sulphur dioxide,** obtained by burning sulphur. The amount usually employed is 1 lb. to 1,000 cubic feet, but this is too small. Various forms of apparatus for burning the sulphur are to be had, and in many of them arrangements are made for rendering the air moist; this increases the efficiency of the gas.

2. **Formaldehyde.**—This is sold as "formalin," which is a 40 per cent. solution of formaldehyde in water. It is a most useful and powerful disinfectant, having no destructive action on the usual furniture of the room, and being very slightly poisonous. Formalin acts as an antiseptic in very dilute solutions, such as 1–1,000, or even weaker. There are many ways of applying it to the disinfection of a room, and many forms of apparatus are sold for the purpose. It is easily applied by boiling a solution of formalin. For 1,000 cubic feet 8 oz. of formalin mixed with 1½ pints of water will be required, and this will take 6 oz. of alcohol to evaporate it. A very simple plan is to saturate a sheet with formalin

by means of a spray, and hang this up in the room. An ordinary sheet will hold 150–180 c.c. (5–6 oz.) without dripping, and this is sufficient for 1,000 cubic feet. The rooms should be closed for seven hours.

STERILISATION BY HEAT

The forms of heat, besides actual destruction by burning, which may be used for sterilisation are—

Dry heat, *i.e.* such heat as may be obtained in an oven.

Moist heat, *i.e.* such heat as is obtained by boiling or steaming.

Dry heat.—A temperature of 287° F. is required with this form of heat to ensure the death of the most resistant spores. Dry heat is difficult to regulate and is both less efficient and more destructive to dressings and such materials than moist heat, which is therefore usually chosen for sterilising purposes. Steel instruments may be sterilised by dry heat, and knives may be passed through the flame of a burner on an emergency, but the temper of the steel is soon spoilt.

Moist heat.—This may be used in three ways—

1. Boiling or heating in a fluid.
2. Exposing to steam from boiling water at 212° F.
3. Exposing to steam under pressure at a temperature of 239° F. In this case boilers or sterilisers capable of withstanding pressure are employed.

The facts to be remembered in regard to the destruction of organisms by heat are—

1. All pathogenic organisms not in the form of spores are killed by heating in a fluid to 158° F. for one hour.
2. That similar forms are killed if actually boiled (*i.e.* at 212° F.) for five to ten minutes.
3. That many spores are killed by boiling for long periods.
4. That all spores are killed by steam at 239° F.

The method of sterilisation chosen should err on the side of safety, and it must always be borne in mind that the temperature registered by the thermometer is not necessarily or even usually the temperature to which the organisms—protected as they often are by badly conducting materials—are exposed.

Heating at less than 212° F. (Pasteurisation).—It may often suffice to free a fluid from pathogenic non-spore-bearing germs without actually sterilising it, which may be done, as has been shown, by prolonged heating above 158° F. This is a problem which arises rarely in surgical practice, but not unfrequently in the preparation of foods, especially milk, which shall be safe and palatable. Milk brought "to the boil" reaches the temperature of 194° F. (not more), but tastes distinctly scalded. At 176° F. the flavour is practically unchanged, but the milk must be kept at this temperature for some time to make sure that *Bacillus tuberculosis* is destroyed.

The process by which foods are freed from organisms which are killed at a comparatively low temperature is known as Pasteurisation. It must be distinctly understood that such foods are not sterile and will not keep for any length of time.

Heating to 212° F. (boiling or steaming).—This is the commonest and easiest way of sterilising most articles used in medical and surgical work. For surgical instruments the water should have 1 per cent. of "soda" added. Sharp-edged instruments should be wrapped in wool to prevent them from being bumped about and blunted by the boiling water. Clothes, sheets, towels, etc., which have been soaked with blood or pus will, if put into boiling water, be permanently stained, as the albumen of these fluids is coagulated in the cloth. They should be rinsed out in cold water to which an antiseptic has been added, before being boiled.

Discontinuous sterilisation at boiling point.—If there were no question of the destruction of spores, no temperature above 212° F. would be required for sterilisation except to render the process quicker. This temperature will, however, suffice to sterilise spore-containing material if applied intermittently. If such a material as milk containing resistant spores is boiled for twenty minutes, all the bacteria will be killed, but the spores may remain alive. If the boiled milk, protected from fresh infection, be then left for twenty-four hours in a warm place, the spores will grow into bacteria, and on boiling the milk once more this fresh crop of organisms will be killed. A third period of twenty-four hours and a third heating will make sure of the destruction of any that may have escaped the second heating. This is a method much used in bacteriology, and useful in food sterilisation, but not of much service in surgical work. It depends for its success on the fact that in the intervals between the heatings the spores can germinate into bacteria; in other words, it is only successful when the material to be sterilised is a cultivating medium, and this is rarely the case in surgical practice.

This method is obviously of no greater use than simple boiling for the sterilisation of ligatures, knives, needles, syringes, and such objects.

Steaming under pressure at temperatures above 212° F.—This method requires a special apparatus capable of standing some pounds of pressure, and made like the boiler of a steam-engine. Such sterilisers are found in nearly every operating-theatre. The most resistant spores are killed in moist heat at a temperature of 239° F. To get the full benefit of the method it is important that all the air shall have been got rid of by escaping steam. The reasons for choosing this method are practical, and based on its certainty, efficiency, rapidity, penetrating power, and the condition of the articles after sterilisation.

To sum up: (1) moist heat is more efficient than dry heat of the same temperature, (2) moist heat causes less damage to articles, (3) moist heat penetrates bulky materials more quickly, (4) high-pressure steam is quicker than steam at 212° F. both because it is of higher temperature and because it penetrates more readily, (5) high-pressure steam leaves the object sterilised in a drier condition than is the case with low-pressure steam.

FILTRATION

Sterilisation by filtration can obviously only apply to fluids, and the most usually filtered material is water. It is sometimes forgotten that saline solutions grow organisms readily, and are often sadly in need of sterilisation. The filters which are of any value for removing bacteria from fluids are made either of porcelain, as in the Pasteur-Chamberland and Doulton filters, or of a compressed infusorial earth, as in the Berkefeld system.

In many operating-theatres water thus sterilised is supplied. It must be remembered that no filters will deliver sterile water for more than a short time, and that they should be cleaned and re-sterilised at least once a week if sterile water is required.

One of the most important uses of filtration is in the preparation of the various antitoxic and therapeutic serums which are employed in medicine. The method is useful where it is desired to obtain a sterile filtrate with as little alteration as possible in the chemical composition of the sterilised fluid.

CHAPTER XV

ELEMENTARY PHARMACY

By C. Edward Sage, F.C.S., Ph.C.

The Examinations of the Society of Apothecaries and the Pharmaceutical Society —Compounding—A Typical Prescription—Preparations—Directions—Names of Metals—Names of Acid Radicals—Contractions for Names of Drugs or Preparations—Forms in which Drugs are Given—Classification of Drugs according to their Effects.

It is often necessary that a member of the nursing staff of a hospital or infirmary should have some knowledge of the methods by which medicines are compounded. Whenever possible, therefore, a nurse should obtain some instruction in a dispensary or a pharmacy.

Should she decide to take up dispensing in a serious spirit she should study Luff and Candy's " Manual of Chemistry," and Whitla's " Pharmacy, Materia Medica and Therapeutics." The former will give her all the information needful in chemistry; the latter all that is required in pharmacy and materia medica except the practical work, which can only be properly learnt under personal supervision.

The Society of Apothecaries holds an examination four times annually, and grants dispensers' certificates to candidates who have satisfied the examiners that they have the requisite skill in dispensing and possess a knowledge of pharmacy, chemistry, and materia medica. Candidates must be at least eighteen years of age, and have received a definite course of instruction in practical dispensing and chemistry during a period of six months.

If a nurse has the opportunity towards the end of her training, she can, of course, study the subject then, but it is wiser, where circumstances permit, to give six months to the work subsequently to finishing at the hospital. Numerous schools of pharmacy are to be found in Great Britain, the fees varying from twelve to eighteen guineas for the six months' course of instruction and practical work. Intending students should make full inquiries before entering a school, and not be too much influenced by advertisements quoting the wonderful salaries to be obtained by lady dispensers. The result is sometimes a fiasco. The training is not always what it ought to be, nor is it true that the position of lady dispenser is highly remunerated. A nurse, however, can use her knowledge of dispensing to advantage in her daily work, and where a Sister who can dispense is preferred, she will often be able to obtain extra payment for her services.

If a young woman takes up pharmacy in the fuller sense of the word, in order to obtain the qualification of the Pharmaceutical Society, she has to serve a three years' apprenticeship with a chemist, pass a preliminary examination in English, French, mathematics and Latin, and afterwards an examination conducted by the Pharmaceutical Society, called the "Minor," which requires a wide range of knowledge of chemistry, botany, pharmacy, materia medica, and dispensing. After passing this examination the successful student may obtain a dispensership, to which a fair salary is attached. But the "Minor" qualification, involving a four years' training, is, of course, very different from the dispenser's certificate, which might be useful to a nurse, and can be taken after a six months' training.

Pharmacy may be divided into two branches: (1) the preparation of drugs and chemicals in a form suitable for their use in medicine, and (2) the compounding of these preparations in some form for the use of patients. We might say that the one was "manufacturing" and the other "dispensing," and we should be near the truth in the case of a hospital nurse, for dispensing a prescription means, literally, not only compounding the various ingredients, but giving the medicine to the patient.

A nurse would never be called upon to manufacture either chemicals or the preparations of drugs, called galenicals, such as tinctures or liquid extracts, for these are always purchased from a wholesale druggist. In a hospital dispensary most of the pills, powders, tablets, and plasters are bought ready made, and it is only a large institution which can afford to employ a fully trained pharmacist to manufacture such things.

COMPOUNDING

Compounding, as we will call the part of pharmacy which is of particular interest to the readers of this work, is the translation of a medical practitioner's prescription, and the preparation of a remedy for internal administration or external application. Now it cannot be too strongly insisted upon that a prescription must be made up exactly as directed, and that the doctor's orders must not be departed from in the least particular without first consulting him. There is only one right way to compound a prescription, and that is to compound it strictly as ordered, without alteration. No substitution of anything "just as good" is permissible at any time.

A **typical prescription** consists of four parts, viz., (*a*) the superscription, (*b*) the inscription, (*c*) the subscription, (*d*) the signature.

The **superscription** consists of a letter ℞, which stands for the Latin word "Recipe," meaning *take thou.* It was originally a symbol which was intended as an invocation to the god Jupiter to "aid the remedy."

The **inscription** consists of the drugs to be used in making the medicine, with the quantity of each.

The **subscription** consists of the directions given by the doctor to the dispenser, and the **signature** is the direction for the patient how to take, or for the nurse how to employ, the remedy. A prescription usually bears also the patient's name at the top, the prescriber's signature or initials at the bottom, and the date. The following may be taken as a model prescription (the words in italics would not, of course, appear in an actual prescription):—

Mrs. Henry Nickelby

Superscription	℞.		
Inscription	Magnes. Sulph.	℥ss.	*Active ingredient*
	Sodii Bicarb.	ʒj.	*Adjuvant*
	Syr. Zingib.	℥j.	*Corrective*
	Aq. Chlorof. ad	℥vj.	*Vehicle*
Subscription	M. fiat Mistura		
Signature	Capiat partem sextam bis die		

17.4.08 C.E.S.

When reading a prescription one's thoughts should be directed first to the ingredients ordered, then to the quantities of each, next to the kind of preparation the prescriber is ordering, and lastly to the directions for the patient, but a nurse will naturally inquire why the

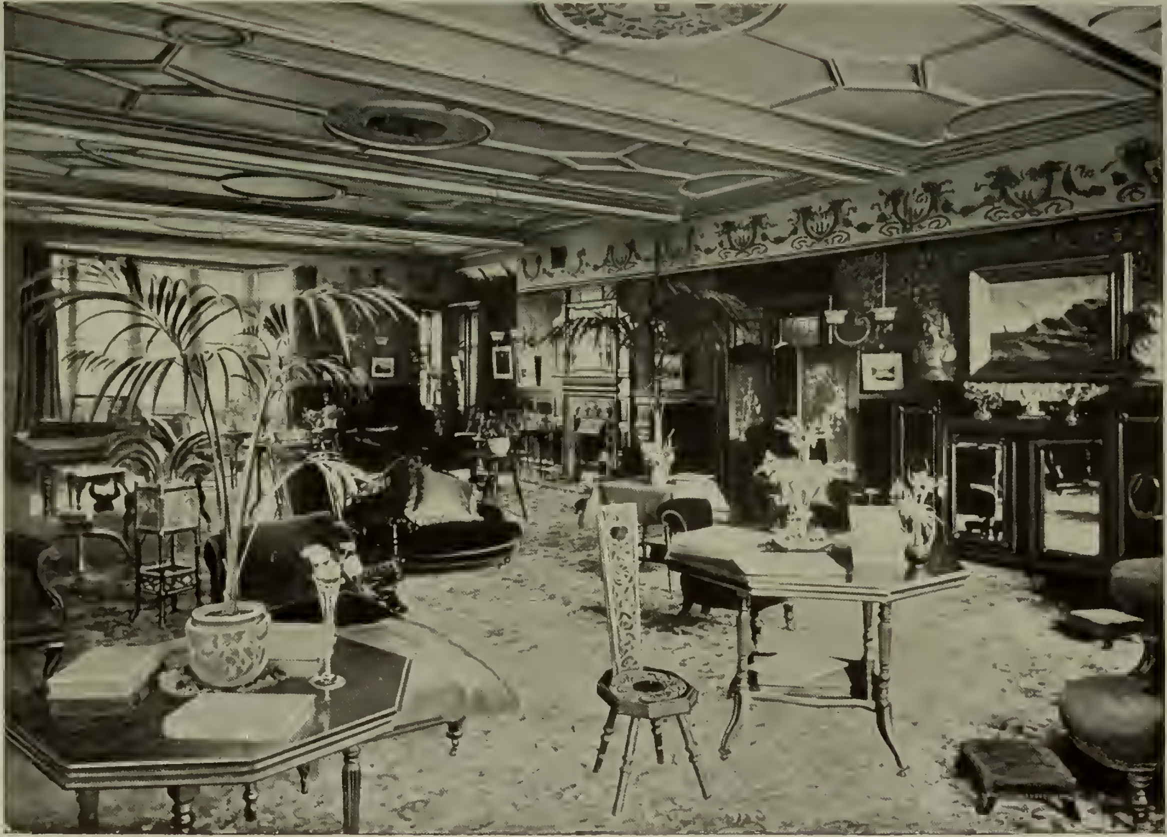

PLATE XXVI.—NURSES' RECREATION ROOM, ROYAL INFIRMARY, EDINBURGH.

various ingredients are used, and then analyse the construction of the recipe from that standpoint.

A typical recipe for a mixture, pill, or powder contains the one or more particular drugs the doctor wishes to administer. In the above recipe the *active ingredient* is the Epsom salts, which will act as a purgative. To remedy any tendency to acidity, the *adjuvant*, bicarbonate of soda, is added. To prevent any tendency to griping, the *corrective*, syrup of ginger, is ordered, and the *vehicle*, chloroform water, is used for much the same purpose.

The vehicle is a most important part of any prescription, for it would be impossible to give a patient a correct dose of a mixture of the few things ordered, and in some instances it would be dangerous to swallow some chemicals, without first dissolving or diluting them. Many chemicals cannot be mixed together because they are incompatible—*i.e.* they decompose each other ; but incompatibility is a subject which requires careful teaching and which can only be mastered by actual experience, for the methods of dealing with the difficulties that arise in connection with prescriptions are numerous and varied.

With the prescription given on the preceding page, the dispenser would first dissolve the bicarbonate of soda in part of the chloroform water, then dissolve the Epsom salts in a further quantity, and mix the two solutions, next measure out the syrup and rinse it from the measure into a bottle with the dissolved salts, and finally fill up the bottle with chloroform water.

For a mixture the prescriber orders the vehicle, but with a prescription for pills the method of making the ingredients into a suitable mass for cutting into pills is left to the dispenser, and it is here that the dispenser's "art" must be displayed. How to send mixtures out to patients, the methods of labelling, into what bottles to put such things as gargles, eye-drops, liniments, poisonous lotions, are little details which have to be studied and appropriately settled by the dispenser.

Ointments and skin dressings are important adjuncts in hospital practice, but they are usually made by machinery and purchased from wholesale druggists, and at the present time a very great deal of labour in dispensing is saved by the use of compressed tablets in which drugs are divided in suitable doses.

To compound medicines such as the mixture ordered in the typical prescription on page 80, it is necessary to have the suitable implements and apparatus. A pair of dispensing scales with a set of weights, glass measures, mortars, stirring rods, spatulas, funnels, and many other etceteras are to be found in all dispensaries, but the actual methods of using them must be learnt by practice.

SYMBOLS, WEIGHTS AND MEASURES

Gr. or gr. = grain
℈j or gr. 20 = 1 scruple
℈ij or gr. 40 = 2 scruples
ʒss or gr. 30 = ½ drachm
ʒj or gr. 60 = 1 drachm
℥j = 1 ounce (Apothecaries' Weight, equivalent to ʒviij, or 480 grains)
fl. ℥j = 1 fluid ounce or 480 minims
♏j or min: j = 1 minim
gtt. j or gutta = 1 drop
Oj or octarius unus = 1 pint
Cj or congius unus = 1 gallon
oz. or ounce = 1 avoirdupois ounce of 437½ grains
A *teaspoonful* should measure 1 fluid drachm
A *dessertspoonful* ,, ,, 2 fluid drachms
A *tablespoonful* ,, ,, 4 fluid drachms or half a fluid ounce
A *wineglassful* usually means 2 fluid ounces
A *teacupful* may be anything between 4 and 6 fluid ounces

The use of graduated measure-glasses should be insisted on by all prescribers. The writer has in his possession tablespoons holding nearly one fluid ounce (*i.e.* twice as much as the doctor intends by a tablespoonful dose), and teaspoons holding quantities varying from one to two-and-a-half drachms.

PREPARATIONS

The following list of the preparations most frequently used gives the Latin and English names, and the contractions of the former ;—

Contraction		*Latin*		*English*
Ac. or Acid.	=	Acidum	=	Acid
Acet.	=	Acetum	=	Vinegar
Aqua or Aq.	=	Aqua	=	Water
Cach.	=	Cachet	=	Cachet
Caps.	=	Capsula	=	Capsule
Conc.	=	Concentratus	=	Concentrated

Contraction		*Latin*		*English*
Dil.	=	Dilutus (*-a-um*)	=	Diluted
Embroc.	=	Embrocatio	=	Embrocation
Enem.	=	Enema	=	Enema
Ext.	=	Extractum	=	Extract
Ext. liq.	=	Extractum liquidum	=	Fluid Extract
Garg.	=	Gargarisma	=	Gargle
Haust.	=	Haustus	=	Draught
Inject.	=	Injectio	=	Injection
Lamel.	=	Lamella	=	Disc
Lin.	=	Linimentum	=	Liniment
Liq.	=	Liquor	=	Solution
Lot.	=	Lotio	=	Lotion
M. or Mist.	=	Mistura	=	Mixture
Neb.	=	Nebula	=	Spray
Ol.	=	Oleum	=	Oil
P. or pulv.	=	Pulvis	=	Powder
Pigment.	=	Pigmentum	=	Paint
Pil.	=	Pilula	=	Pill
Syr.	=	Syrupus	=	Syrup
Tab.	=	Tabella	=	Tablet
Tinct. or Tr.	=	Tinctura	=	Tincture
Tinct. Co.	=	Tinctura composita	=	Compound Tincture
Troch.	=	Trochiscus	=	Lozenge
Ung. or Unguent.	=	Unguentum	=	Ointment

DIRECTIONS

The following are the most frequent abbreviations and phrases employed in the directions to the dispenser and those for the patient :—

Contraction		*Latin*		*English*
Aa.	=	ana (Greek)	=	of each
—		ad	=	to, or up to
Ad lib.	=	ad libitum	=	at liberty, at pleasure
—		adde	=	add thou
Alt. die	=	alterno die	=	every other day
A.M.	=	ante meridiem	=	before noon
—		ante	=	before
Ante coen.	=	ante cœnam	=	before supper
Ante jentac.	=	ante jentaculum	=	before breakfast
Ante prand.	=	ante prandium	=	before dinner
Applicand.	=	applicandus	=	to be applied
Aq.	=	aqua	=	water
Aq. ad	=	aquam ad	=	(add) water up to

Contraction	*Latin*	*English*
Aq. bull.	= aqua bulliens	= boiling water
Aq. calid.	= aqua calida	= hot water
Aq. dest.	= aqua destillata	= distilled water
Aq. frigid.	= aqua frigida	= cold water
B.P.	—	= British Pharmacopœia
B.P.C.	—	= British Pharmaceutical Codex
—	bis	= twice
C.	= congius	= a gallon
c.	= cum	= with
C.c.	—	= cubic centimetre
C.m.	= cras mane	= to-morrow morning
C.n.	= cras nocte	= to-morrow night
Cap.	= capiat	= let him take, or, take
Cib.	= cibum or cibus	= food or meals
C. or coch.	= cochleare	= a spoonful
Coch. mag.	= cochleare magnum	= a large spoonful—*i.e.* a table spoonful
Coch. med.	= cochleare medium	= a dessertspoonful
Coch. min.	= cochleare minimum	= } a teaspoonful
Coch parv.	= cochleare parvum	=
Coch. parv. ij	= cochlearia parva duo	= two teaspoonfuls
—	cœna	= supper
Collun.	= collunarium	= nasal douche
Collut.	= collutorium	= mouth wash
Collyr.	= collyrium	= eye wash
Cuj.	= cujus	= of which
Cyath.	= cyathus	= a glass
D.	= dosis	= a dose
D.	= detur	= let it be given
D.d.u.	= dum dolore urgente	= whilst the pain lasts
D.s.	= detur signetur	= let it be given and labelled
—	deinde	= then
—	die	= a day
—	diebus alternis	= every other day
—	donec	= until
—	dum	= whilst
—	duo	= two
E. or ex	= ex	= out of
—	et	= and
Ex aq.	= ex aqua	= in water
Fort.	= fortis	= strong
Ft.	= fiat	= let it become, or let it be made
Ft. emp.	= fiat emplastrum	= make a plaster
Ft. haust.	= fiat haustus	= make a draught

Contraction		*Latin*		*English*
Ft. lin.	=	fiat linimentum	=	make a liniment
Ft. mist.	=	fiat mistura	=	make a mixture
Ft. neb.	=	fiat nebula	=	make a spray
Ft. pil.	=	fiat pilula	=	make a pill
Ft. ung.	=	fiat unguentum	=	make an ointment
Grm.	=	gramma	=	gramme
Gtt.	=	guttæ	=	drops
H.	=	hora	=	an hour
H.n.	=	hora nocte	=	at night
H.n.	=	hac nocte	=	this night.
H.p.	=	hora prandio	=	dinner time
H.s.	=	hora somni	=	bed time
H.s.s.	=	hora somni sumenda	=	let it be taken at bedtime
Hebdom.	=	hebdomada	=	a week
Hirud.	=	hirudines	=	leeches
—		in die	=	during the day
Inf.	=	infusum	=	infusion
Inj.	=	injectio	=	injection
Inj. hypoderm.	=	injectio hypodermica	=	hypodermic injection
Inst.	=	instanter	=	instantly
Insufflat.	=	insufflatio	=	insufflation
—	=	lac	=	milk
lb.	=	libra	=	pound
Lev:	=	levis	=	light
Lin.	=	linimentum	=	a liniment
Liq.	=	liquor	=	a solution
M. or min.	=	minimum	=	a minim
M.	=	misce	=	mix
M.d.	=	more dictu	=	in the manner directed
M.d.s.	=	more dictu sumendus	=	to be taken as directed
M.d.u.	=	more dictu utendus	=	to be used as directed
M., ft. mist.	=	misce, fiat mistura	=	mix, make a mixture
M., ft. pil. xx.	=	massa, fiant pilulæ viginti	=	mass, make twenty pills
Mass.	=	massa	=	pill mass
Mit.	=	mitis	=	weak
Mit.	=	mitius	=	weaker
—		mitte	=	send
N.	=	nocte	=	at night
O.	=	octarius	=	a pint
O.m.	=	omni mane	=	every morning
O.n.	=	omni nocte	=	every night
Opt.	=	optimus	=	best
P.a.a.	=	parti affectæ applicandum	=	to be applied to the affected part
P.m.	=	post meridiem	=	afternoon

Contraction	*Latin*	*English*
P.m.	primo mane	first thing in the morning
P.p.a.	phialâ prius agitatâ	the bottle having been first shaken
P.r.n.	pro re nata	as occasion requires
Part. affect.	parti affectæ	to the affected part
Ph.	phiala	bottle
Poc.	poculum	a cupful
Ppt.	preparata	prepared
Q.	quantum	quantity
Q.q.	quaque	every
Q. 4tis horis	quaque quartis horis	every 4 hours
Q.s.	quantum sufficiendum	a sufficient quantity
Rad.	radix	root
Rec.	recens	fresh
S., st., or sum.	sumat	let him take
S.a.	secundem artem	according to art
—	semel	once
Sing.	singuli	one at a time
S.o.s.	si opus sit	if necessary
Ss. or ſs.	semis	half
St.	statim	at once
—	ter	thrice
—	ter in die	thrice daily
—	tres, tria	three

NAMES OF METALS

Contraction	*Latin*	*English*
Alum.	Aluminium	Aluminium
Antim.	Antimonium	Antimony
Arg. or Argent.	Argentum	Silver
Arsen.	Arsenium	Arsenic
Bism.	Bismuthum	Bismuth
Calc.	Calcium	Lime
Cupri	Cuprum	Copper
Ferri	Ferrum	Iron
Hyd. or Hydrarg.	Hydrargyrum	Mercury
Iodi	Iodum	Iodine
Lith.	Lithium	Lithium
Magnes.	Magnesium	Magnesia
Mangan.	Manganesium	Manganese
Plumbi	Plumbum	Lead
Pot. or Potass.	Potassium	Potash
Sod. or Sodii	Sodium	Soda
Zinc.	Zincum	Zinc

NAMES OF ACID RADICALS

Contraction		*Latin*		*English*
Acet.	=	Acetas	=	Acetate
Benz.	=	Benzoas	=	Benzoate
Bic. or bicarb.	=	Bicarbonas	=	Bicarbonate
Bor.	=	Boras	=	Borate
Brom.	=	Bromidum	=	Bromide
Carb.	=	Carbonas	=	Carbonate
Chlor.	=	Chloridum	=	Chloride
—	=	Chloras	=	Chlorate
Chrom.	=	Chromas	=	Chromate
Cit.	=	Citras	=	Citrate
Hyd.	=	Hydrochloridum	=	Hydrochloride
Hypophosph.	=	Hypophosphitum	=	Hypophosphite
Mur.	=	Muriaticus	=	Hydrochloride
Nit.	=	Nitras	=	Nitrate
Ox.	=	Oxidum	=	Oxide
Perchlor.	=	Perchloridum	=	Perchloride
Permang.	=	Permanganas	=	Permanganate
Phosph.	=	Phosphas	=	Phosphate
Salicyl.	=	Salicylas	=	Salicylate
Subchlor.	=	Subchloridum	=	Subchloride
Sulph.	=	Sulphas	=	Sulphate
Tart.	=	Tartras	=	Tartrate

CONTRACTIONS FOR NAMES OF DRUGS OR PREPARATIONS IN COMMON USE

Contraction		*English Name*
Acid. Acet.	=	Acetic Acid
Acid. Carbol.	=	Phenol ("Carbolic Acid")
Acid. Hydrocayn. Dil.	=	Dilute Prussic Acid
Acid. Nit. Mur. Dil.	=	Dilute Nitro-hydrochloric Acid
Aconit.	=	Aconite
Æth.	=	Ether
Aloes Barb.	=	Barbadoes Aloes
Aloes Soc.	=	Socotrine Aloes
Ammon. Brom.	=	Bromide of Ammonia
Ammon. Carb.	=	Carbonate of Ammonia
Amylum	=	Starch
Anethi	=	Dill
Anisi	=	Anise
Aq.	=	Water
Aq. Dest.	=	Distilled Water
Aq. Menth. Pip.	=	Peppermint Water

Contraction		*English Name*
Argent. Nit.	=	Silver Nitrate
Aurant.	=	Orange
Bellad.	=	Belladonna
Buchu	=	Buchu
Caffein. Cit.	=	Citrate of Caffeine
Cal.	=	Calomel (Hydrarg. Subchlor.)
Calc.	=	Calcium or Chalk
Camph.	=	Camphor
Cannab. Ind.	=	Indian Hemp
Cantharidin.	=	Cantharides
Capsic.	=	Capsicum
Cardam.	=	Cardamoms
Carui	=	Carraway
Caryoph.	=	Cloves
Casc. Sagr.	=	Cascara Sagrada
Cascarill.	=	Cascarilla
Chloral Hydr.	=	Hydrate of Chloral
Chlorof.	=	Chloroform
Cimicif. (or Actea)	=	Cimicifuga
Cinch.	=	Cinchona
Cinnam.	=	Cinnamon
Cocain.	=	Cocaine
Codein.	=	Codeine
Colch.	=	Colchicum
Coloc.	=	Colocynth
Conf. Sennæ	=	Confection of Senna
Copaib.	=	Copaiva
Emp. Plumb.	=	Diachylon Plaster
Euonym.	=	Euonymus
Gelsem.	=	Gelsemium
Gent.	=	Gentian
Glycer.	=	Glycerine
Glycyrrh.	=	Liquorice
Guaiac.	=	Guaiacum
Hamam.	=	Hamamelis
Hydrarg. Bichlor.	=	Corrosive Sublimate
Hydrarg. Perchlor.	=	
Hydrarg. Subchlor.	=	Calomel
Hydrast.	=	Hydrastis
Hyoscy.	=	Henbane
Iodof.	=	Iodoform
Jaborand.	=	Jaborandi
Junip.	=	Juniper
Kramer.	=	Rhatany

Contraction		*English Name*
Limon.	=	Lemon
Lin. Ammon.	=	Hartshorn and Oil
Lin. Camph.	=	Camphorated Oil
Linteum	=	Lint
Liq. Ammon. Acet.	=	Solution of Acetate of Ammonia
Liq. Arsen.	=	Solution of Arsenic
Liq. Fowleri	=	
Liq. Pot. Arsen.	=	
Liq. Calcis.	=	Lime Water
Liq. Donovani	=	Donovan's Solution
Liq. Ferr. Perchlor.	=	Solution of Perchloride of Iron
Liq. Mag. Carb.	=	Fluid Magnesia
Liq. Morph. Mur.	=	Solution of Hydrochloride of Morphia
Liq. Plumbi Dil.	=	Goulard Water
Liq. Plumbi Fort.	=	Goulard Extract
Liq. Strych.	=	Solution of Strychnine
Lot. Nig.	=	Black Wash
Mag. Sulph.	=	Epsom Salts
Mel. Borac.	=	Borax and Honey
Mist. Senn. Co.	=	Black Draught
Ol. Amygd.	=	Almond Oil
Ol. Eucalyp.	=	Eucalyptus Oil
Ol. Jecoris	=	Cod-liver Oil
Ol. Morrhuæ	=	
Ol. Oliv. Opt.	=	Olive Oil
Ox. Scill.	=	Oxymel of Squills
Paraff. Moll.	=	Vaseline
Podoph.	=	Podophyllum
P. Opii	=	Powdered Opium
Pot. Bicarb.	=	Bicarbonate of Potash
Pot. Bitart.	=	Cream of Tartar
Pot. Permang.	=	Permanganate of Potash
Quin. Sulph.	=	Sulphate of Quinine
Rad. Gent.	=	Gentian Root
Rhei.	=	Rhubarb
Sarzæ.	=	Sarsaparilla
Seneg.	=	Senega
Sod. Bicarb.	=	Bicarbonate of Soda
Sod. Citro-Tart. Eff.	=	Citrate of Magnesia (so-called)
Sp. Ammon. Aromat.	=	Sal Volatile
Sp. Eth. Nitros.	=	Sweet Spirit of Nitre
Sp. Frument.	=	Whiskey
Sp. Vini Gallici	=	Brandy
Sp. Vini Rect.	=	Rectified Alcohol (90 per cent.)

Contraction		*English Name*
Strophanth.	=	Strophanthus
Strych.	=	Strychnine
Sulphur Præcip.	=	Milk of Sulphur
Sulphur Sublim.	=	Sulphur
Supp. Morph.	=	Morphine Suppositories
Syr. Ferri Phosph.	=	Syrup of Phosphate of Iron
Syr. Ferri Phosph. Co.	=	Parrish's Syrup
Syr. Ferr. Phosph. c̄ Quin. et Strych.	=	Easton's Syrup
Tarax.	=	Dandelion
Tereb. or Ol. Terebinth.	=	Turpentine
Tr. Benzoin Co.	=	Friar's Balsam
Tr. Camph. Co.	=	Paregoric
Tr. Cardam Co.	=	Compound Tincture of Cardamoms
Tr. Chlorof. et Morph.	=	Chlorodyne
Tr. Ferr. Perchlor.	=	Tincture of Iron
Tr. Opii	=	Laudanum
Tr. Quin. Ammon.	=	Ammoniated Tincture of Quinine
Ung. Hydrarg. Co.	=	Scott's Dressing
Ung. Hydrarg. Mit.	=	Weak Mercury Ointment
Vin. Antim. Tart.	=	Antimonial Wine
Vin. Ferr.	=	Iron Wine
Vin. Ipecac.	=	Ipecacuanha Wine
Zinc. Sulph.	=	Sulphate of Zinc
Zingib.	=	Ginger

FORMS IN WHICH DRUGS ARE GIVEN

FOR INTERNAL USE

Cachets are rice-paper wafers stamped out in a mould, and in them powders or pill masses may be placed in order that these may be swallowed without being tasted.

Capsules of gelatine are employed in the same way for administering fluids.

Decoctions are fluid preparations made by boiling a drug in water for a definite period and then straining off the liquid. Only a few decoctions are used in medicine, but Decoct. Hordei (barley water) is often employed in the sick room.

Extracts are solids, or paste-like solids, obtained by extracting a drug with a suitable liquid, and then evaporating so as to remove all the liquid. Liquid extracts are, practically speaking, strong tinctures of such a concentration that one fluid ounce represents the active principles from one ounce of drug.

Infusions are fluid preparations made by steeping a drug in boiling water, without maintaining the temperature, for a definite period, and straining. They are usually employed as vehicles for making up mixtures, and the only potent one ever met with is infusion of digitalis.

Juices are the expressed products of fresh plants; they are usually preserved with alcohol.

Liquors are solutions of chemicals which are kept prepared to save weighing out small quantities of potent or deliquescent chemicals.

Lozenges are solid bodies made with a sugar basis and flavoured, and containing a suitable medicament. Some, intended to act in the mouth or throat, dissolve in the saliva; others are only dissolved in the stomach.

Mixtures may be defined as fluid preparations intended for administration, in definite doses, by the mouth. The Pharmacopœia contains the formula for a few definite mixtures, such as Mist. Cretæ, M. Ferri, M. Sennæ Co., and Castor Oil mixture, but every hospital has a number of private formulæ for such things. Tonic, alterative, antacid, cough, diarrhœa and aperient mixtures are usually kept ready prepared in concentrated form to save stocking a big volume of each preparation.

Pills are solid medicaments in a spherical form made by combining one or more drugs with a substance, called an excipient, which will make the drug into a hard paste; this latter is then rolled out into a pipe and cut into equal portions and rounded.

The pills used in hospitals are usually made, as we have said, by manufacturing druggists, but occasionally at a hospital, and very frequently in a pharmacy, pills have to be made from any one or more ingredient which a doctor may prescribe, and then the dispenser's skill is required in order to make the drugs into a paste which can be cut and rounded. Nothing but experience will produce a successful pill mass, fit to cut up on a pill machine. To prevent the patient from tasting the pills, they are coated in various ways—pearl-coated with French chalk, sugar-coated like sugared almonds, varnished, covered with gelatine, or else silvered; but more often they are rolled in powder to keep them from sticking together, for which purpose lycopodium, starch, or French chalk is usually employed.

Powders are usually definite doses of one or more drugs weighed up and wrapped in paper. They have been almost superseded by tablets and tabloids.

Spirits are alcoholic solutions of substances which are insoluble in water. Sal volatile and spirits of nitrous ether are of a complex character, but most of the spirits are simple solutions of essential oils in alcohol.

Syrups are solutions of chemicals or mixtures of drugs combined with sugar.

Tablets, or, as one manufacturing firm calls them, tabloids, are rounded disc-like solids, consisting of one or more drugs which have been compressed into pellet form by machinery. Some are intended to be swallowed entire, others to be dissolved in water ; like pills, some are coated and others are not.

Many tablets are rendered almost insoluble by compression, and should therefore be broken up before they are taken.

Tinctures are fluid preparations made by macerating a drug in spirit and either pressing out the liquid, or else allowing the spirit to drain away, and adding more so that it may percolate through the drug, and so extract all that is soluble or useful. The tinctures for which official formulæ are given in the British Pharmacopœia are numerous, for they are the most useful liquid form in which to keep drugs prepared.

Wines are solutions of either drugs or chemicals in sherry or orange wine.

FOR EXTERNAL USE

Blisters are small portions of cantharides plaster spread on adhesive plaster and intended for the production of a blister on the skin in some definite area.

Enemata are fluid preparations thickened with starch mucilage or containing soap, intended for introduction to the bowels *per rectum.*

Gargles are fluids containing an antiseptic or an astringent intended for application to the throat and tonsils.

Hypodermic injections are solutions of drugs or chemicals intended for insertion under the skin.

Lamellæ are small disc-like portions of gelatine containing some drug for application to the eye.

Liniments and **embrocations** are, as a rule, fluid oily preparations intended for application to the skin.

Lotions are usually watery preparations intended for application to the surface of the body on lint or rags, or else for bathing an injured part.

Ointments are fatty solids containing a medicament intended for local application to the skin. They are made by mixing together the special ingredient and either vaseline, lard, lanoline, cold cream, or a special combination of hard and soft paraffin.

Oleates are chemical compounds prepared from oleic acid and some mineral or potent alkaloid. The soaps are chiefly oleates, but the term "oleate" in pharmacy is more commonly applied to the mercury, zinc, quinine, cocaine, or veratrine compounds.

Pigments are fluid or cream-like preparations for local application to the skin.

Plasters are solid medicaments made with a wax-like basis and containing a drug, intended for application to the skin.

Poultices are usually made with linseed meal or bread-crumb and boiling water, and are used hot to foment the part to which they are applied.

Suppositories are small conical bodies made of cocoa butter, and containing some medicament intended for administration *per rectum.* **Pessaries** are made with the same basis and a drug, and are intended for insertion into the vagina, whilst **bougies**, made in long pencil-like form, are for insertion in the urethra.

CLASSIFICATION OF DRUGS ACCORDING TO THEIR EFFECTS

Alteratives.—Remedies which gradually change or correct any morbid condition. Examples: antimony, mercury, and arsenic preparations.

Anæsthetics.—Drugs or chemicals which suspend consciousness or sensation. They may be general or local. General anæsthetics: chloroform, A.C.E. (alcohol, chloroform, ether) mixture, ether, ethyl chloride, nitrous oxide gas. Local anæsthetics: cocaine, ucaine, novocaine, etc.

Analgesics or **anodynes.**—Remedies which relieve pain by their action on the brain or on the nerves. Examples: opium, Indian hemp, belladonna, camphor, chloral hydrate, exalgine, phenacetin.

Anhydrotics.—Remedies which restrain profuse perspiration. Belladonna and zinc oxide are frequently prescribed. Dilute acids, ergot, picrotoxin, and quinine are also employed.

Antacids or **alkalies.**—Chemicals which neutralise acids. They are used to check excessive acidity in the stomach, and for this purpose sodium bicarbonate, potassium bicarbonate, and ammonium carbonate are chiefly employed.

Antalkalies.—Acids which increase acidity in the contents of the stomach and urine. Those used for this purpose are hydrochloric (dil.), nitro-hydrochloric, nitric, phosphoric, citric, and tartaric.

Antemetics are substances used to prevent or allay sickness. Examples: bismuth salts, effervescent saline mixtures.

Anthelmintics are used internally to cause the expulsion of worms from the bowels. Examples: santonin, kousso, and pelletierine.

Antilithics.—Remedies which help to prevent the formation of calculi or which render the salts in urine more soluble. Examples: Lithia salts, alkaline bicarbonates, piperazine, fluid magnesia, Rochelle salt, and benzoates.

Antiperiodics.—Medicines which prevent the periodical return of fever. Examples: quinine, salicin, and arsenic.

Antipyretics.—Preparations which reduce the abnormally high temperatures in cases of fever. Examples: acetanilide, antipyrin, quinine salts, phenacetin, salicin, "sp. eth. nit."

Antiseptics.—Substances which prevent the growth of micro-organisms. Examples: carbolic acid, cresylic acid, boric acid, iodoform, mercury cyanide and bichloride, eucalyptol, salicylic acid, peroxide of hydrogen, potassium permanganate, and zinc sulphocarbolate.

Antispasmodics.—A comprehensive group of remedies which tend to prevent the occurrence of spasms. Remedies like Calabar bean and the bromides act on the motor centres, and those which produce general depression of the vital functions, such as tobacco, aconite, veratrine, and hydrocyanic acid, are usually called sedatives.

Aphrodisiacs.—Drugs which excite the functions of the genital organs. Examples: phosphorus, cantharides, strychnine and nux vomica, alcohol and damiana.

Astringents are used for hardening or contracting the mucous surfaces. Examples: tannin, gallic acid, rhatany, acid infusion of roses, zinc salts, iron preparations.

Carminatives.—Medicines used to dispel gases from the stomach or bowels. Examples: asafœtida, cardamoms, chloroform, peppermint, valerian, ginger.

Cathartics.—Drugs or chemicals which increase or hasten the evacuation of the bowels. They may be grouped as follows:—

Laxatives increase the peristaltic movement of the bowels. Examples: Cascara sagrada, confection of senna, pulv. glycyrrh. comp., magnesia, effervescent salines, sulphur, taraxacum.

Purgatives increase the movements and stimulate the secretions of the bowels. Examples: aloes, calomel, castor oil, senna.

Hydragogue cathartics produce watery motions. Examples: sulphate of magnesia, sulphate of soda, jalap, colocynth.

Cholagogue cathartics directly increase the flow of bile. Examples: dilute mineral acids, antimonium sulphuratum, euonymus, colocynth, jalap, podophyllin, calomel.

Caustics.—Substances which destroy the tissues to which they are applied. Examples: glacial acetic acid, carbolic acid, chromic acid, strong mineral acids, silver nitrate, creosote, liq. soda ethylatis, hydrarg. perchlor., zinci chloridum.

Demulcents.—Bodies which protect or allay irritation of the mucous membrane. Examples: acacia, almond oil, glycerine, barley water, mucin, slippery elm, white of egg.

Desiccants.—Drying agents, which usually take the form of dusting powders. Examples: boric acid, calamine, starch, oxide of zinc, kieselguhr, and Fuller's earth.

Diaphoretics.—Remedies which increase cutaneous secretion and produce sweating. Examples: liq. ammon. acet., sp. eth. nit., pulv. antimonialis, pulv. ipecac. co., jaborandi, potass. nit., and sp. camphoræ.

Diuretics.—Medicines which increase the flow of urine either by stimulating the kidneys or by raising the blood pressure in the glomerules. Examples of the former: liq. amm. acet., ammon. benz., buchu, juniper, and potash salts; of the latter: digitalis and squills.

Ecbolics.—Substances which cause contraction of uterine muscular fibre. Examples: ergot, hydrastine, quinine, savin, and strong purgatives.

Emetics are employed to produce vomiting. Those most frequently used are ipecacuanha, sulphate of zinc, and apomorphine.

Emmenagogues.—Drugs which stimulate or maintain a healthy menstrual discharge. Examples: decoct. aloes co., apiol, ergot, iron preparations, potass. permang.

Expectorants cause a loosening of phlegm. Examples: ipecacuanha (in small doses), senega, liquorice, quillaia.

Galactagogues.—Medicines which increase the secretion of the mammary glands. Examples: potassium chlorate, fennel.

Hæmatinics.—Substances which enrich the blood by acting as restoratives of the red corpuscles. Examples: iron salts, hæmoglobin, manganese salts.

Hypnotics.—Medicines which induce sleep, without first causing excitement. Examples: ammon. brom., camphor monobrom., chloral hydrate, chloralamid., hyoscyamus, paraldehyde, sulphonal, trional, urethane.

Mydriatics.—Substances which, when placed in the eye, cause dilatation of the pupil. Examples: atropine, belladonna, cocaine.

Myotics.—Substances which cause contraction of the pupil. Examples: eserine (physostigmine) and pilocarpine.

Narcotics.—Drugs which produce sleep by their action on the cerebrum. Examples: opium, morphine, Indian hemp, ether, chloroform.

Refrigerants.—Preparations used to cool the body during fever. Examples: dilute acids, lemon juice, pot. chloras, pot. nit., sp. eth. nit.

Rubefacients.—Remedies which, applied to the skin, cause redness and a sense of warmth. Examples: acetic acid, turpentine, lin. camph., lin. camph. ammon., lin. sinapis, menthol plaster.

Sedatives.—Medicines which exert a soothing effect on the nervous system, the circulatory system, or some particular organ of the body. Examples: morphine, chloral, codeine, conium, chloroform, belladonna, digitalis, hydrocyanic acid, veronal.

Sialagogues.—These increase the flow of saliva. Examples: dilute acids, ipecacuanha, mercury salts, iodides, pellitory, pilocarpine, mustard, and ginger.

Sternutatories.—Substances which irritate the nasal mucous membrane and so cause sneezing. Examples: tobacco (snuff), hellebore, capsicum, quillaia and veratrine.

Styptics.—Substances which arrest local bleeding. Examples: tannin, alum, ferri perchlor., hamamelis.

Tonics.—Medicines which improve the strength or tone of some organ of the body. They may be either nervine, stomachic, cardiac, or hepatic.

Vesicants.—Substances which applied to the skin produce a blister. Examples: cantharides, mylabris, chloral hydrate, hydrarg. biniodide.

CHAPTER XVI

THE ELEMENTS OF PUBLIC HYGIENE AND SANITARY LAW

By A. H. Hogarth, M.B., B.Ch.(Oxon.), D.P.H.

Air—Water—Soil—Food—Houses and other Buildings—Communicable Disease—Table of Incubation and Quarantine Periods and Leading Symptoms of the Commoner Eruptive Fevers—Physical Condition of the People.

Preventive medicine is a science of which the scope is ever growing wider, and it should become more and more the aim of the nurse, as of the medical practitioner, to prevent rather than to cure disease. I therefore invite attention to some common public health problems.

I.—AIR, WATER, SOIL AND FOOD

Air, water, food and sunlight are prime necessities of life. They all have certain natural qualities and properties; the first three are also subject to natural and added impurities, from which they may be protected or purified in certain recognised ways. These two facts, then, will form a convenient basis for their study. The soil also must be considered.

AIR

Air is a mechanical mixture of oxygen and nitrogen, with varying amounts of water vapour and carbon dioxide gas. Traces of sulphur and ammonia gases may be found in the air of towns. Of these gases, oxygen is the essential constituent for human life, nitrogen acting as a diluent, while the remaining components are natural or added impurities.

It is important to realise that air is a mechanical mixture, and not a chemical compound, for its composition per cent. varies within certain limits. When freed from water vapour it may be represented thus :—

Oxygen	20·96
Nitrogen	78·00
Argon	1·00
Carbon dioxide	0·03
Impurities	0·01
	100·00

The percentage of oxygen is reduced, and that of carbon dioxide—popularly known as carbonic acid—increased, in crowded, ill-ventilated rooms, and in mines. In expired air carbon dioxide reaches 4.5 per cent., while the oxygen is reduced to 16.5 per cent. External respiration, or breathing, consists in the intake of atmospheric air, the abstraction of oxygen by the blood, and a simultaneous exchange and discharge of carbon dioxide and water vapour into the air. The combustion of coal-gas also increases the amount of carbon dioxide, as much as two or three cubic feet being given off every hour by an ordinary bat's-wing burner.

In the open there is an unlimited supply of oxygen, which, except in the case of badly planned areas and cul-de-sacs, is constantly being renewed by means of the wind and other agencies. Under cover the supply is obviously limited. An adult is estimated to give off 0.7 cubic feet of carbon dioxide per hour, and the amount is increased upon exertion.

Air-space.—Although carbon dioxide is not dangerous or really harmful in small quantities, yet its percentage serves as a convenient index of the impurity of the air. To prevent the accumulation of bad air and to secure a standard of purity, it is calculated that an adult requires at least 3,000 cubic feet of fresh air every hour. (*See* p. 6.) But the air in a room cannot be completely "changed," so to speak, more than three times an hour without inconvenient draughts. Therefore every adult requires 1,000 cubic feet of air space (or better still ten square feet of floor space)—a requirement difficult to satisfy in schools, public rooms, etc., and thus constituting one aspect of the ventilation problem.

Mechanical and other impurities.—Moreover, as the result of trade processes, of combustion and of disease, the air may acquire certain mechanical, chemical and bacterial impurities. The constant breathing of metallic dust, of stone dust, sawdust, etc., is an important factor in increasing the mortality from phthisis and other lung diseases. This is especially noticeable in the case of Cornish tin miners, quarrymen, file makers, and men engaged in earthenware manufacture. In chemical works the employees may also be exposed to noxious fumes and gases, which can be speedily removed by proper ventilation, and which are soon diluted in the open air, just as are the ordinary products of combustion.

The bacteriology of the air is not very important, except in connection with surgery. Large numbers of bacteria may be found in a fairly clean room, but possibly very few in an offensive atmosphere. Perhaps the number may be taken as some indication of the habitual cleanliness of a room. Bacteria vary very much in kind, and occasionally the specific organisms of disease may be present. Influenza is an air-borne disease, and smallpox undoubtedly is spread by aërial convection. The dust and particulate matter in air are of more importance than bacteria; for, without dust and dirt, the bacteria of air could not live, except in the form of spores.

WATER

Every adult requires a daily supply of twelve to fifteen gallons of pure water for personal and for domestic use. In the houses of many of the poor not more than three or four gallons per head are used daily —an insufficient amount for healthy living.

Cisterns.—If the supply of water is not "constant," it must be stored in cisterns, where it loses its freshness, and is liable to pollution from dust, dirt and animals. Iron cisterns rust; lead cisterns are dangerous. Galvanised iron is the best material. A cistern should be fixed in a light and well-ventilated room; it must be completely covered and should be cleansed three or four times a year. A separate flushing cistern is necessary for each water-closet. Municipal and trade purposes account for a further daily consumption of about fifteen gallons of water per head of population.

Soft and hard water.—Water is derived from rain, and is naturally *soft* and pure. It becomes contaminated in its course through the air, and more so as it comes into contact with things of the earth, when it takes up certain organic matters which may be oxidised and rendered harmless as the water filters through the soil. Shallow and superficial wells, especially near dwellings, cowsheds, etc., are likely to be contaminated, and should for this reason be avoided. The first and obvious rule about every water supply is that its source must be examined to ascertain the absence of direct and indirect causes of contamination. It is unfortunate that most river water used for drinking purposes is polluted at its source, and, though its impurity becomes reduced by oxidation and dilution, yet it is well to remember that "there is no river in the United Kingdom long enough to effect destruction of sewage by oxidation." In addition to gross organic pollution (which is indicated by the detection of an increased percentage of chlorides, nitrates, and ammonia), water is subject to other impurities, both chemical and bacterial. It dissolves lime and other mineral salts, and so becomes *hard.*

The hardness of a water may be either temporary or permanent or both. *Temporary* hardness is due to the presence of calcium bi-carbonate, which is deposited as a fur upon kettles when water is boiled. *Permanent* hardness depends upon the presence of calcium and magnesium sulphates and magnesium chloride, which sometimes cause gastric irritation and diarrhœa. The disadvantage of hard water for washing purposes is commonly known, and is due to precipitation of calcium or magnesium salts, which retard lathering, much soap being thereby wasted.

Soft water has the power of oxidising lead, and of making it soluble; and more so in the presence of an acid. Hence the danger of lead pipes and cisterns, especially for moorland waters, which are commonly acid as the result of bacterial action upon peat. In the case of hard water, calcium carbonate is deposited on lead pipes, forming a protective coat against the action of the water. In no case should water be allowed to stand in lead pipes.

Bacteria in water.—The number of bacteria per cubic centimetre of water affords a rough estimate of its purity. Thus if a particular sample of water contains no dangerous bacteria and not more than 100 bacteria of any kind per cubic centimetre, it is said to be "good," if the number exceeds 500, it should be considered of dubious quality, and "undrinkable" if the number exceeds 1,000 per cubic centimetre. The majority of organisms found are harmless, a few are potentially harmful, such as *Bacillus coli communis*, streptococci, and *Bacillus enteritidis*. These afford prima facie evidence of sewage contamination. The specific organisms of typhoid, cholera and dysentery are seldom found, even in specifically polluted waters; and, fortunately, they soon lose their vitality.

Filter-beds.—It is obvious, therefore, that the storage, softening, purification and filtration of public water supplies is a necessary measure. This is carried out by means of filter-beds. Lime and magnesia salts are removed by the addition of lime-water, which combines with carbon dioxide and allows the salts to be precipitated. Organic matter and bacteria may be reduced as much as 98 per cent. by sand-filtration, or by filtering through spongy or scrap iron. Nevertheless, as prevention is better than cure, all water supplies should be strictly protected from sewage contamination.

Purification of drinking water.—For domestic purposes, boiling softens temporarily hard water, but renders it flat and insipid for drinking. It may, however, be aërated again. Boiling also kills all organisms, including the specific bacteria of disease, and is, therefore, the only absolute means of purification. Many varieties of domestic filter have been invented, but they require great care and attention. Sooner or later, the majority of them add more bacteria and organic matter to the water than they remove. An efficient filter should remove all suspended impurities and a large percentage of organisms, should diminish the amount of organic matter by oxidation, should add nothing harmful, and above all should be periodically cleansed. Bischoff's spongy iron filter diminishes the hardness of water, while filtration through animal charcoal or spongy iron removes lead. Special porcelain filters (Pasteur-Chamberland or Berkefeld) prevent the passage of all bacteria, but they require much attention.

Water as a source of disease.—Drinking water is sometimes a potent source of disease. Lead poisoning and diarrhœa from saline water have been incidentally mentioned. Any sewage-contaminated water may give rise to severe diarrhœa, though it is frequently drunk with impunity. Typhoid fever and cholera are essentially water-borne diseases, and dysentery may be spread in the same way. A few parasitic diseases are conveyed by water. Rickets, goitre, and urinary calculi have commonly been ascribed to impure drinking water, but little positive evidence is forthcoming.

SOIL

Soil is of great importance both from the geologist's and from the builder's point of view, but here we need only consider its bacteriological aspect.

Putrefaction and oxidation.—The soil is a great purifier, and apart from the question of agriculture, it plays an invaluable part in the world's economy. Putrefaction and oxidation are both the result of bacterial action. Dead organic matter is first decomposed, by one group of organisms, into simple substances such as nitrogen, ammonia and carbon dioxide. This constitutes putrefaction. Nitrogen and ammonia are oxidised, by another group of organisms, into nitrites and nitrates, which help to fertilise the soil. Without these two processes the whole inhabited world would soon become a pestilential mass. The amount of available nitrogen in the soil is increased by a third group of bacteria which exist in certain roots and plants and which have the power of "fixing free nitrogen."

A few disease-bearing germs flourish in the soil, *e.g.* the anthrax bacillus, and especially the tetanus bacillus, which is found in garden soil and in stable manure. Hence the great importance of cleansing thoroughly all wounds impregnated with dirt. The organisms of typhoid fever and cholera undoubtedly survive for long periods in soil, and may sometimes cause local outbreaks of disease. Sewage-polluted and damp soils appear to be detrimental to health. Epidemic diarrhœa is associated in some way with earth and soil, but the general relations between "telluric" conditions and disease are matters too complicated to enter into here.

FOOD

The natural properties and qualities of food stuffs are well known; their scientific aspect may be studied in text-books of physiology. But public health is intimately concerned with questions of the source, adulteration and storage of many food materials. Supervision and control are obviously necessary. Contaminated milk supplies have been responsible for epidemics of scarlet fever and diphtheria; tainted meat has caused outbreaks of ptomaine poisoning, and is also a potential source of tuberculosis; outbreaks of arsenical poisoning have been traced to beer, and epidemics of typhoid fever to oysters.

Cleanliness in the handling of all foodstuffs is, of course, desirable, but in the case of milk it is essential. A pure milk supply should be derived from clean, healthy, non-tubercular cows; it should be carefully protected from contamination not only at milking but also in the processes of straining and cooling, as well as during transmission. The strictest precautions as to absolute cleanliness of hands and utensils should be observed. There should be no opportunity for the introduction of dust or dirt at any time. Finally, milk should always be stored in clean vessels, and in suitable places, whether it be in the dairy or in the home. If these precautions are neglected, bacteria gain access and multiply so rapidly—especially in warm milk—that by the time it comes to the consumer a cubic centimetre of milk may contain several million germs.

Orders and regulations for the supervision of dairies, cowsheds and milkshops exist, but no real progress in the control of milk supplies will be effected until compliance is more rigidly enforced in all districts. Meanwhile, as far as milk is concerned, a nurse's chief duty will be to ensure its proper storage in the homes which she visits.

Many varieties of bacteria are found in milk, including those of air and water, certain bacteria of fermentation, sewage and intestinal microbes, the specific organisms of tuberculosis, typhoid fever and diphtheria, and many others. The souring of milk is due to bacterial fermentation ; milk sugar is changed into lactic acid and casein is precipitated. There are several other kinds of fermentation. The tubercle bacillus gains access to milk from the cow's udder, but probably does not very often induce human tuberculosis, considering the large amount of tubercular milk which is consumed.* Epidemics of scarlet fever and diphtheria have frequently been traced to milk supplies. Cows may possibly be subject to diphtheria. Epidemic diarrhœa in infants depends largely upon the consumption of contaminated milk.

Sterilisation (that is, prolonged boiling) of milk kills all the germs, but the flavour and composition are altered. On the other hand, if milk is heated to a temperature of 158° F. for ten minutes—a process known as "pasteurisation"—practically all living germs are killed without altering its properties.

Various laws exist for the seizure of **unsound food**; and no one may sell "to the prejudice of the purchaser" any injurious or adulterated food or drug. There are special regulations for the sale of milk, butter, margarine, etc. The sampling and detective system, as practised in England, is useful ; but, in the case of meat, it is not satisfactory owing to the absence of public slaughterhouses where all cattle may be inspected and all marketable meat officially stamped.

Meat, especially when it is imperfectly cooked, may convey certain parasitic diseases. It may also cause ptomaine poisoning and tuberculosis.

The chief *parasites* which are conveyed to man through meat are—(1) tapeworms ; one variety in pork, another in beef—in both cases the diseased meat has a so-called "measly" appearance due to numerous yellowish white vesicles, which contain the young of the worms (*Cysticercus cellulosæ*); (2) liver flukes in sheep; (3) *Trichina spiralis*, which causes trichiniasis in man—a disease at one time common in Germany and America from the consumption of half-cooked sausages and pork.

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* Between 20 and 30 per cent. of milch cows in Great Britain are tubercular, and 2 per cent. of them have tubercular disease of the udder. The tubercle bacillus has been detected in 14 per cent. of samples of milk for sale in large provincial towns.

Ptomaine poisoning, which is the result of poisoning by the products of bacterial activity, may arise from unsound or tainted meat—whether properly cooked or not—or from imperfect or unclean methods of preservation and storage. Several epidemics have been traced to the consumption of pork pies, brawn, ham, etc., and a particular group of organisms has been associated with the disease.

Simple decomposition of meat may cause gastric irritation and diarrhœa, and may lead to general poisoning. Such meat may be recognised by its watery or discoloured appearance, also by its want of firmness to the touch, and by its smell. Decomposition is first apparent in the flesh near the bone, and may be easily detected by thrusting a clean table knife into the meat until the bone is reached. When withdrawn the surface of the knife will be found smeared with juice which by its smell indicates the presence or absence of decomposition.

Tuberculosis is not commonly spread by meat; but, so long as it is a potential source of the disease, stricter supervision is called for with a view to carrying out the recommendations of the Royal Commission on Tuberculosis. Diseased meat cannot be thoroughly sterilised by ordinary methods of cooking, as sufficient heat does not penetrate to the centre of the joint.

II.—HOUSES AND OTHER BUILDINGS

"An Englishman's house is his castle, but he may not make of it a pestiferous dungeon or a source of injury to his neighbour's health."* Neither may the landlord. These limitations express the general obligations of tenant and landlord with regard to public health. Hence a number of bye-laws and regulations concerning sanitation have sprung up. In practice a specific nuisance may be the result of a tenant's neglect, or of a landlord's economy, and, in the latter case, a sanitary conscience at the landlord's expense often leads to the eviction of poorer tenants. At all events, it is the sanitary authority's duty to exercise strict supervision by means of house-to-house inspection. So far as a house is concerned, the following are statutory nuisances under the Public Health Acts :—

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* Annual Report of Mansion House Council on the Dwellings of the Poor (1907).

(1) Any premises in such a state as to be
(2) Any gutter, watercourse, privy, urinal, cesspool, drain, or ashpit, so foul or in such a state as to be ....
(3) Any animal so kept as to be........
(4) Any accumulation or deposit which is

a nuisance or injurious to health.

The Public Health (London) Act, 1891, adds the words "*or dangerous to health.*"

(5) Any house or part of a house so overcrowded as to be dangerous or injurious to the health of the inmates.

"A public or common nuisance," according to Blackstone," is anything which worketh hurt, inconvenience or damage." In other words " a nuisance is something which either actually injures, or is likely to injure health, and admits of a remedy either by the individual whose act or omission causes the nuisance, or by the local authority." (Winter-Blyth.)

In London absence of proper water supply, or of proper fittings, renders a house unfit for habitation. There are also regulations concerning underground rooms. A sanitary inspector has the right of entry at all reasonable times into all premises where he has reason to believe a nuisance or an insanitary condition exists, and his right of entry can be enforced. Private houses occupied by one family do not, as a rule, require much supervision. But there are special regulations for tenement houses (or houses occupied by members of more than one family), which are registered, and may be exempted from inhabited house duty upon the medical officer of health's certificate as to their sanitary state. In populous districts many block dwellings have been erected partly by private semi-philanthropic efforts and partly by municipal enterprise. The sanitary condition, equipment and management of the more recently constructed dwellings are satisfactory, but even so there are many objections to them, and of late there has been a tendency in favour of decentralisation, and of housing artisans in double tenement cottages in outlying districts. Common lodging-houses (*i.e.* lodging-houses where persons of the poorer classes sleep in dormitories, and have the use of common living-rooms and kitchens) are registered and placed under strict supervision.

Generally speaking, the tenant is responsible for the cleanliness and the management of his rooms, while the landlord is liable for structural repairs, drainage, ventilation and periodical cleansing, as to which, as well as in regard to conditions of occupancy, overcrowding, general sanitation, etc., there are adequate model bye-laws. But as to the general question of what constitutes a danger to health, there may be considerable dispute.

Occupancy.—Living-rooms should be so constructed as to allow approximately 1,000 cubic feet for each person. If this standard were adopted, and if the means of ventilation and lighting were adequate, little would be heard of the ill effects of bad housing conditions. The Local Government Board *minimum* standards are 400 cubic feet per head for rooms in which persons both live and sleep, and 300 cubic feet per head for rooms used solely as bedrooms or as living-rooms. Two children under ten count as one adult.

In private houses and in the more recently constructed model dwellings and country cottages these conditions prevail, but in populous districts there are many unwholesome dwellings which give rise to such symptoms as anæmia, lassitude, fatigue, headache, and which may sometimes be a cause of the spread of tuberculosis and other infectious and contagious diseases. By degrees—very slowly, it is true—everyone is learning the value of ventilation.

Natural ventilation of rooms depends upon the dilution of vitiated air with fresh air, which is brought about by "diffusion currents," partly due to the action of wind, and partly to differences of temperature. Cold air descends, hot air ascends. All windows should be made to open top and bottom, and should admit of complete through or cross ventilation between door and window, or window and window. Additional inlets and outlets may be provided. Every room should have its fireplace, and the chimney should never be stopped up. When the fire is lighted, the chimney serves as an excellent outlet for vitiated air. The general rooted objection to open windows and draughts has been responsible for the introduction of many patent ventilators and openings, some of which are of little practical value, except in large buildings. The dust and dirt of populous districts are the worst drawbacks to the open window. To diminish the effect of draught, the lower half of the window may be propped open in all its width by means of a solid strip of boarding, to allow the admission of fresh air in an upward direction between the two sashes.

Artificial ventilation has been found necessary chiefly in the case of public buildings, schools, hospitals, etc. There are two systems: (1) Fresh air is driven along ducts by means of revolving fans, and admitted to rooms through inlets, while the vitiated air is displaced through outlet ducts. (2) Impure air is removed by exhaust fans, or by heated outlet shafts. The latter process is specially useful in factories, etc., where dust or gaseous fumes have to be removed speedily. These systems have not yet been perfected, and the installations are costly.

Apart from the supply of fresh air or the removal of vitiated air, a sense of relief is often experienced in an over-heated atmosphere when the air is kept pleasantly moving by a revolving fan, thereby increasing evaporation from the skin. It cannot be described as an ideal method of ventilation, though the ill effects of bad air are probably more often due to the excessive temperature than to any specific poisons such as carbon dioxide. One advantage of mechanical ventilation is that the fresh air may be screened, washed and warmed before it is introduced. Its temperature can be easily regulated.

Warming.—Warming may also be secured by hot-water or steam pipes (high or low pressure), which heat the room by convection, and are apt to make the air unpleasantly hot and dry. The same objection applies to the use of closed stoves, with which there is the additional danger of a discharge of dangerous carbon monoxide fumes. Gas fires are clean and economical, but there is the risk of gas escaping into the room, and great attention must be paid to the adequacy of the flue. For private houses and small rooms an open fireplace has many advantages. It is cheerful, acts as a thoroughly efficient ventilator, and heats the room by radiation without making the air too dry. Excessive coal-bills may be reduced by the use of a slow-combustion grate, while careful construction will render most of the heat available for the room.

Water supply.—The importance of a good water supply to all houses is obvious. It is a difficult matter in rural districts, where it is the duty of the sanitary authorities to insist upon the presence of "an available supply of wholesome water within a reasonable distance." All water from doubtful sources should be boiled. The L.C.C. General Powers Act, 1907, enforces the supply of water to the upper storeys of high block dwellings; and it must be remembered that in London the absence of a proper water supply and of proper fittings renders a house unfit for habitation.

Removal of refuse and drainage.—The cleanliness of a house depends upon its tenant, but there are regulations for the periodical cleansing of registered tenement-houses and common lodging-houses. The removal of refuse is in the hands of the sanitary authority. Most kitchen refuse should be burnt, but ashes, etc., should be removed in "sanitary pails" by scavengers at frequent intervals. The removal of lavatory slops and excreta by "water carriage" constitutes the drainage of a house.

A **drain** is a pipe used for the drainage of one building, and is repairable at the owner's expense, whereas a **sewer** is a drain receiving drainage from two or more premises, and is vested in the sanitary authority. A **trap** is simply a bend in a drain pipe; it holds a "seal" of water to prevent the passage of drain gas backwards. A **soil pipe** carries excreta from the closet downwards directly to the drain; it should be placed on the outside wall of a house, and should be continued upwards above the level of the house-top. It is left open for the complete ventilation of the drain, air entering at an "interceptor" or at an inspection chamber where the drain joins the sewer. "Drains," as is remarked in Whitelegge and Newman's "Hygiene and Public Health," "should be so constructed that in no circumstances can their contents, liquid, solid or gaseous, escape from them at any but the points specially provided for this purpose. This result is attained by the choice of proper material for their construction and by sound workmanship, by trapping all inlets, so as to prevent the egress of drain gases, and, lastly, by efficient ventilation at suitable points."

It is the function of a sanitary inspector to investigate and to discover the source of defects, but every householder, every health visitor, and every nurse should know whether the above conditions obtain or not, and should realise a few important common-sense principles. With regard to **water-closets**, the flush should be adequate (say, two gallons of water), and they should be self-cleansing; the pan should be absolutely clean; there should be no smell; the "water-seal" should remain effectual; above all, the flush should come from a separate cistern, and not from a service pipe; and with regard to drains, etc., there should be no leakage or smell. In the case of poorer dwellings, water-closets are often unsatisfactory, whether from neglect or from ignorance. But both causes must be overcome by education and strict supervision, as there is no doubt that " water carriage " is the most satisfactory system for towns. In villages and outlying cottages, the use of a sanitary pail with the addition of ashes is simple, economical, and efficient. The contents should be removed once or twice a week.

In London and other large towns many of the slum areas have been cleared away by municipal activity, and there are stringent regulations as to the construction of new houses and the laying out of new streets, but much yet remains to be done in the way of " town planning," in order to prevent the reappearance of congested areas, and to secure the co-operation of " traffic boards," adjacent local authorities, building companies, and other bodies with a view to erecting model buildings and double tenement cottages, with sufficient breathing-space for all, with green playgrounds for the children, and with easy travelling facilities to the central districts for the bread-winners. Important alterations in the law on these subjects have been incorporated in the Housing, Town Planning, etc., Act, 1909.

The hygienic standard of house sanitation has gradually been raised with the increase of medical knowledge during the last twenty years, but there is still a great work to be done in the schools. Everyone should be taught the elements of healthy living and of personal hygiene. And towards this end nurses have an opportunity for playing their part, whether as district nurses, as health visitors, or as nurses in the schools.

III.—COMMUNICABLE DISEASE

To limit the spread of certain recognised infectious and contagious diseases is an important branch of public health work. This is associated very closely with a knowledge of bacteriology, a subject which has already been dealt with in Chapter XIV. It remains to consider how the commoner diseases are spread, how they may be checked, and what are their chief characteristics from the public, rather than from the individual, standpoint.

The occurrence of a **specific disease** in man implies the pre-existence of the same disease in some other person or persons, whether already recognised or not ; it is dependent upon some definite ("specific") cause, such as a micro-organism or its poisonous products. If such a specific disease tends to spread from one person to another, it is called **infectious** or **contagious**; if an outbreak of the disease spreads rapidly through a community or through a country, it is called **epidemic**, and if it extends over a large part of the inhabited world, it is said to be **pandemic**, while the term "**endemic**" is reserved for a specific disease which is constantly found in a particular locality or country.

Communicable diseases, then, are dependent upon living organisms, microbes or germs. They are spread from an infected person or animal by—

(1) Close personal contact: breath, coughing, sneezing, kissing, etc...
(2) Excreta and other discharges.....
(3) Direct inoculation...............
(4) Parasites, fleas, mosquitoes, etc...

Through the medium of air, water, milk and soil, or by means of drinking-vessels, clothes, blankets, books, dust, sand and flies.

In addition, dirt, bad air and other unwholesome and insanitary conditions undoubtedly help to spread, rather than to check, the disease, while personal susceptibility and lowered body resistance also act as favourable predisposing causes to an attack of any disease that happens to be epidemic or endemic. Moreover, mild and unrecognised cases are fruitful sources of infection. The possible means for the communication of infectious diseases are legion, especially when it is recognised that some germs may lie dormant for months and years in the various media above indicated waiting only for a favourable opportunity to attack a human host. This was well illustrated by the epidemic of typhoid fever in 1903 in the training ship *Cornwall* off Purfleet, resulting from the use of blankets which had been infected with disease germs during the South African War. But, generally speaking, each disease has its peculiar method, or methods, of transmission.

Signs and symptoms do not appear immediately after a disease has been communicated. There is first a latent or incubation period, in which the germs or their poisons are accumulating strength to overcome the resistance of the body, and which varies for different diseases. This period over, the patient is suddenly taken ill. Headache, shivering, vomiting, pains in the back, usher in an attack of a febrile disease. Then a rash appears; in some diseases early, in others it is deferred for several days. At all events, its appearance is one of the most characteristic signs of the disease. In typhoid fever, the onset is insidious, and the rash does not appear until the end of the first week. Though infectious diseases generally follow a definite and prescribed course, they are liable to variations in character.

Sooner or later they will be classified according to their bacteriology. Meanwhile two important factors must be borne in mind, namely, the **type of the disease** and the **susceptibility of the individual.** For instance, sore throat is the chief symptom of several communicable diseases, which, like a common cold or influenza, are specially infectious if they are associated with coughing, sneezing or nasal discharge. There are at least three forms of communicable sore throat, (1) ulcerating tonsillitis, dependent upon the presence of streptococci; (2) membranous tonsillitis, or diphtheria, due to the Klebs-Löffler bacillus; and (3) scarlet fever, due to some unknown micro-organism; and though each of these diseases is a separate entity, yet they have many characters in common. Moreover, each of these diseases may be subdivided into many types, probably dependent partly upon different organisms, and partly upon the individual susceptibility or immunity. Some types are very mild, others very severe. From the point of view of public health, the mild cases are the worst, as they are often neglected or unrecognised; and yet they may be the means of conveying infection to susceptible persons. The contagium or living organism may be harboured for months in an apparently healthy or convalescent throat. This is undoubtedly true of diphtheria, and, by analogy, it is probably true of the other infections. Hence "carrier" cases may prolong an epidemic, and may be the real cause of fresh sporadic cases, which are thought to take their origin from drains and other insanitary conditions. It is possible, also, that an individual may himself harbour the germs of a serious disease, which cannot establish itself until the whole bodily vitality is sufficiently lowered.

In the case of epidemics, and in dealing with actual cases of sore throat, there is real practical value in the frequent spraying or gargling of the throat; all sore throats should be treated as guilty until proved innocent, and in the case of diphtheria this is easily done. Generally speaking, the presence of enlarged tonsils and adenoid growths increases the susceptibility of patients to all these diseases, and also adds to the danger and severity of an attack. Little is really known about individual susceptibility, except that some persons are very susceptible to one or all of these conditions, while others seem equally insusceptible. Probably the type of the disease and the individual susceptibility are the most important factors in determining the incubation period. All of these diseases may be air-borne; none probably are water-borne, but epidemics of scarlet fever, diphtheria and epidemic sore throat have frequently been traced to milk supplies, the disease being either indirectly transmitted from the cow, or resulting from subsequent contamination. There may also be some association with similar diseases in certain domestic animals.

Schools are probably not such a serious factor in the spread of disease as is commonly supposed.

Every exertion should be made to protect infants and small children from these communicable diseases as well as from measles, whooping-cough, etc. For, with increasing years the children become less susceptible, and the attack itself is attended with less risk and severity.

These preliminary remarks have prepared the way for the consideration of a few details as to the incubation and quarantine periods, and the most salient symptoms, of the commoner infectious diseases.

Scarlet fever.—The incubation period commonly lasts from twenty-four to seventy-two hours, but may extend to ten or fourteen days, especially in mild types of the disease. The onset is sudden, and is accompanied in severe cases by headache, vomiting, fever and sore throat. The rash (which is often evanescent and not noticed) appears on the second day. The course of the disease is definite according to the various types — (1) anginal; (2) hæmorrhagic; (3) malignant; and when the patient survives, it is followed by desquamation (peeling of the skin). All cases of the disease, even the mildest, are apt to lead to serious sequelæ, such as otorrhœa and nephritis. Therefore careful nursing is essential, even in the mildest cases, for a period of several weeks. Quarantine for susceptible contact cases should be kept up for ten days or a fortnight. One attack generally affords protection.

Diphtheria.—The incubation period in definite and traceable cases varies from two to seven days; it is generally about three or four days. The onset is more gradual than in scarlet fever, but sore throat, fever and general malaise make their appearance from the first. The diagnosis is assured as soon as patches of yellowish membrane appear on the tonsils or elsewhere and can be submitted to bacteriological examination. Nasal discharge may be the first sign of one form of the disease. The sooner the diagnosis is made the better, because diphtheria is one of the diseases that medicine can cure and can prevent. The whole nature of the disease has been completely transformed by the use of diphtheria antitoxin, which should be administered as early as possible, and, to be really useful, not later than the third or fourth day of the disease.

Measles.—The specific cause is not known. The disease is probably due to a micro-organism, and the infection is almost certainly air-borne, the result of close personal contact. It is a disease of infancy, and one attack, as a rule, protects against another. The result is that 75 per cent. of children above five years of age in London are protected. The incubation period is about twelve days. The onset is sudden, but fever is associated with catarrhal symptoms, running at the eyes and nose, cough and slight laryngitis and bronchitis for three days before the typical blotchy rash appears. Meanwhile the disease may have spread far and wide during its most infective period. Hence the difficulty of limiting an epidemic by notification and isolation. In fact, owing to the ignorance of parents, measles is an uncontrollable disease: the school is the only place where any useful attempt can be made to control it. Therefore schools should not be closed, but "unprotected" children (i.e. those who have not had measles) should be excluded from affected class-rooms or departments. The disease is generally not severe; complications are usually the result of neglect.

German measles (Rötheln) is a distinct and definite disease with a characteristic rash which appears on the first or second day after an incubation period of a fortnight. It is not a serious complaint, and has no dangerous complications. It is not very infectious, but isolation should be enforced for ten days, and quarantine of contact cases should extend just over a fortnight.

Whooping-cough is in many respects analogous to measles, and is an equally serious disease. It is similarly transmitted by close personal contact. The incubation period is twelve to fourteen days. The onset is insidious, as the characteristic cough does not appear for a week or so after the initial symptoms, during which time the disease is particularly infectious. Notification and isolation are of little practical value. The consequences of neglect and the associated complications are the worst feature of the disease.

From the public health point of view the after-effects of measles and whooping-cough, and of other childish ailments, constitute a very serious problem. These diseases follow one another in rapid succession, and often leave the child in a debilitated state. And, if serious pulmonary complications have supervened, the impaired mucous membrane and the enlarged bronchial glands offer a suitable soil for the deposit and growth of the tubercle bacillus. It is probable that a very large percentage of pulmonary tuberculosis originates in this way. Here, then, is a very wide and useful field in which public health workers may carry out the elementary and common-sense principles of preventive medicine.

Mumps is a specific infection of the parotid and submaxillary glands, causing swelling of both. It is very infectious. The incubation period is very long, generally three weeks.

Typhoid fever, due to the invasion of the alimentary canal by the *Bacillus typhosus*, is not transmitted so much by close personal contact as by means of the excreta (fæces, urine and other discharges) of an infected or convalescent patient. Thus epidemics are often the result of a polluted water supply, and the disease may be spread by sandstorms and by flies, as in the South African campaign. The thorough disinfection of all excreta and discharges is a point of the greatest practical importance. Milk only becomes a vehicle for the transmission of the disease when infected water has been used for cleansing pails, etc., but oysters from polluted sewage beds have frequently caused local outbreaks. In the same way its origin may be traced to watercress and ice-cream. The incubation period varies from a few days to three weeks, according to the type of the disease and individual susceptibility. The onset is for the most part extremely insidious, and the rash does not appear until the end of the first week. Attention has recently been drawn to the importance of "carrier" cases in causing local outbreaks of the disease and of sporadic cases.

Epidemic diarrhœa is the name given to an acute specific disease of which diarrhœa is the chief symptom. It is very common and very fatal in infancy. It is also common among the older patients of infirmaries and other institutions. The cause of this disease is not quite clear, but appears often to be due to a bacillus (*Bacillus enteritidis sporogenes*) first described by Klein. The disease may be checked by attention to cleanliness and sanitation in and around the house, to the careful protection of food, and especially of milk, from contamination. Overripe fruit is often the exciting cause of an attack.

Influenza is a very acute, infectious disease, caused by the invasion of a minute bacillus. It is spread, as in other infectious diseases, by discharges from the nose and mouth, and possibly also by the breath. The bacilli perhaps cling to clothes, books, etc., and may thus be conveyed from place to place. But the widespread occurrence of some outbreaks suggests that it is peculiarly an air-borne disease; for its pandemic nature was recognised long before the increased travelling of the present day facilitated its transference by personal contact. The incubation period is very short, generally one or two days—it may be only a few hours ; and the onset is often extremely sudden and violent.

It is undoubtedly a general constitutional disease, sometimes causing definite septicæmia or blood-poisoning ; but, generally speaking, it attacks one particular system with characteristic symptoms—catarrhal and pulmonary, nervous, or gastric.

The complications are even more serious than the disease, and in old age, or in the case of previously debilitated patients, its mortality rate is exceedingly heavy. One of the worst complications is the serious mental depression which it leaves behind in a convalescent patient.

One attack, so far from affording protection and immunity, appears to render many individuals more susceptible to the disease. Isolation and disinfection are quite as important in this as in other infectious diseases.

Cerebro-spinal meningitis, popularly known as "spotted fever," in its epidemic form, is an acute febrile disease, causing inflammation of the meninges of the brain and spinal cord, sometimes due to the *Pneumococcus*, more generally to the *Diplococcus intracellularis meningitidis.* The infectious nature of the disease is now beyond dispute ; but it is probably only those cases with nasal discharge or otorrhœa which are infective. At all events, there is considerable ignorance as to how the disease is spread. It is apparently air-borne, and the germs may find an entrance into the system through the tonsils. Sporadic cases frequently occur when there is no epidemic. The disease chiefly affects children, and is characterised by its abrupt onset with nervous shock, intense pain at the back of the head and neck, and retraction of the head, followed by delirium and coma. The eruption usually appears on the second, third, or fourth day of the disease. Isolation and disinfection should be carried out.

Puerperal fever includes "septicæmia, pyæmia, septic peritonitis, septic metritis and other acute septic inflammations in the pelvis, occurring as the direct result of childbirth." These diseases may be prevented by strict attention to the principles of asepsis, and by securing wholesome and sanitary conditions for the nursing of all women at childbirth.

Smallpox is a disease of the unvaccinated. Its prevalence has been universal, but it is kept under absolute control in countries where vaccination and revaccination are compulsory. Its incubation period is usually twelve days. The onset is sudden, and begins with shivering, vomiting, headache and pains in the back. The characteristic rash (little shotty pimples which soon become vesicular and finally pustular) appears on the third day, first on the face and wrists, then on the rest of the extremities, and only to a slight extent on the trunk. Very strict precautions as to early diagnosis, isolation, and thorough disinfection, and as to the quarantine of contact cases, should be enforced. Above all, vaccination and revaccination should be urged.

Vaccination.—The Local Government Board supply public vaccinators with pure glycerinated calf lymph, and the Vaccination Acts require that every child shall be vaccinated within six months of birth unless (1) the parent obtains a certificate of exemption from a Justice of the Peace, or (2) three unsuccessful attempts have been made, or (3) a medical certificate of postponement is obtained. Revaccination is not compulsory, but it should be urged after the lapse of ten years.

Chickenpox is chiefly important because it is sometimes mistaken for smallpox, and *vice versâ*. It is mainly a disease of childhood. The incubation period is about fourteen or fifteen days. The characteristic watery vesicles appear on the first day of the disease.

Nurses, especially those engaged in district work, will find it of service to have, in a form that admits of easy reference, a succinct statement of the chief symptoms of the infectious diseases most frequently encountered. The following list is therefore appended :—

TABLE OF INCUBATION AND QUARANTINE PERIODS AND LEADING SYMPTOMS OF THE COMMONER ERUPTIVE FEVERS

DISEASE	USUAL INCUBATION PERIOD	DAY OF DISEASE ON WHICH RASH APPEARS	CHARACTER OF RASH	DISTRIBUTION OF RASH	EARLY SIGNS OF DISEASE	PERIOD OF QUARANTINE FOR SUSCEPTIBLE CONTACT CASES
	Days					*Days*
Scarlet Fever*	2–5	2nd	Minute red dots surrounded by paler area. Soon become diffuse and bright red	Neck, front of chest, inside of thighs, and flexures. It may extend to face and over whole body (except round the mouth and on palms of hands and soles of feet)	Sudden onset, headache, vomiting, sore throat, furred tongue with red dots	14

* *See* starred footnote next page.

DISEASE	USUAL INCUBATION PERIOD	DAY OF DISEASE ON WHICH RASH APPEARS	CHARACTER OF RASH	DISTRIBUTION OF RASH	EARLY SIGNS OF DISEASE	PERIOD OF QUARANTINE FOR SUSCEPTIBLE CONTACT CASES
	Days					*Days.*
Measles	10–14	4th	Deep red slightly raised spots, grouped in patches. "Blotchy" appearance	Face first, trunk next, limbs last. Spreads quickly	Bad cold in the head, sneezing, running at eyes and nose. Swelling of eyelids	16
Diphtheria*	2–4	—	—	—	Sore throat, difficulty in swallowing, nasal discharge	10
Typhoid*	14–21	6th or 7th	Small scattered rose-red spots	Abdomen and trunk	Gradual onset, headache, lassitude, diarrhœa, or constipation	Unnecessary
Whooping Cough	10–14	—	—	—	Catarrhal symptoms. Characteristic cough appears at end of week	21
German Measles	14	1st to 3rd	Minute red spots, which run together and become patchy like measles	Trunk and lower extremities. Sometimes on face and arms first	Enlargement of lymphatic glands, especially at back of neck	16
Mumps	21	—	—	—	Swelling of parotid and submaxillary glands	21
Chicken-pox†	10-15	1st	Small rose spots, soon developing into watery vesicles	Chiefly on trunk, also on the face	Very few	16
Smallpox*	12–14	3rd	Scattered shotty pimples, soon become vesicular and then pustular	Face, neck, and wrists, then on the extremities. Not so well marked on trunk	Sudden onset. Rigors, vomiting, pain in back	16
Cerebro-spinal Meningitis†	—	2nd to 4th	Rose-coloured spots or hæmorrhagic patches	Trunk and extremities. Spots on face more regular	Abrupt onset, severe pain at occiput, nervous shock, retraction of head, rigid muscles	—

* Notifiable Diseases. The following also appear on the scheduled list: Membranous Croup, Cholera, Typhus, Plague, Puerperal Fever, Erysipelas, Continued Fever, Relapsing Fever, Ophthalmia Neonatorum, and Tuberculosis.
† Added to the scheduled list of notifiable diseases from time to time.

Notification and isolation.—Infectious diseases may be kept under observation and control by notification and isolation, while their spread may be checked, to some extent, by disinfection and by supervision of contact cases. A medical practitioner is under penalty to notify to the Sanitary Authority all cases of infectious diseases upon the scheduled list, and then it is the duty of the Medical Officer of Health to make inquiries and to adopt precautionary measures. Any sanitary authority may provide an isolation hospital, but, practically speaking, such a provision is confined to the larger urban districts. The Medical Officer of Health may enforce the removal to hospital of any infected person without proper lodging and accommodation, and patients (or their guardians) can generally be persuaded to avail themselves of the obvious advantages of an isolation hospital at the expense of the rates. In London the Metropolitan Asylums Board has charge of all the isolation hospitals, and of the arrangements for ambulance transport, etc. Many regulations are in force to secure harmony and co-operation between local sanitary authorities, the London County Council and the Metropolitan Asylums Board, such as notifications and weekly returns. Moreover, the head teachers are notified of infectious cases, and of contact cases on the rolls of the various schools.

From the point of view of the Medical Officer of Health this general system of notification is invaluable. He gets the earliest possible knowledge of all cases in his district, and has the power to make full investigation by means of his inspectors and health visitors, who ought to obtain detailed particulars upon special forms for each disease. Information is required (1) as to the probable source of the infection, from a previous known case at the home, the factory or the school, (2) as to the number of inmates in the house, (3) their susceptibility to the disease, (4) the water and milk supplies, and a host of similar matters.

The Medical Officer of Health, like a general on the battlefield, with his sanitary inspectors and health visitors as intelligence and executive officers, directs operations from his office, and by means of charts and maps forms a clear idea of what is happening in his district, as to whether the epidemic is spreading, or is under proper control, whether it has originated from the factory or from the milk supply. He must not formulate theories, he must wait for facts.

When a case has been notified and removed to an isolation hospital, it is necessary to secure thorough disinfection of the premises, and of all infected articles, such as clothes, bedding, etc. In London every sanitary authority must provide disinfecting apparatus for this purpose.

Quarantine.—In the old sense of the term (that is, keeping of contact cases on board a ship for a prescribed number of days) quarantine is found to be impracticable, and not very useful in the light of improved methods. But the supervision of contact cases in land epidemics is both practical and expedient. In smallpox absolute quarantine should be enforced, and vaccination urged. Careful supervision and exclusion from work are necessary in the case of workers in dairies, bakeries, restaurants, etc., and also in the tailoring and clothing trades. As far as schools are concerned, it is easy to exclude contact cases during the prescribed time for each disease.

If a patient elects to remain at home, or if there is no isolation hospital, then the Medical Officer of Health must insist on the observance of strict precautions under the supervision of the medical practitioner and nurse. A light, airy room should be chosen at the top of the house, and no one should have access to it but the nurse. If others are admitted, strict precautions as to clothes, washing of hands, etc., should be enforced. Separate plates, forks and kitchen utensils should be reserved for patient and nurse, and these should be washed and disinfected before leaving the room. A carbolic sheet hung over the door is useful in impressing the infectious nature of the disease upon the lay mind, but in other respects it is useless. All the patient's excreta, etc., should be thoroughly disinfected. Rags, etc., should be burnt, while bed-clothes and wearing apparel should be soaked in disinfecting solution before being washed. The room should be cleaned daily, and dusted with a damp cloth. During convalescence an adjacent room should be used in the daytime.

The final disinfection of the room is very important.* Great care must be taken to secure thorough disinfection of clothes, blankets, etc., by steam. They should be removed by the sanitary authority to a disinfecting station.

IV.—PHYSICAL CONDITION OF THE PEOPLE

Ignorance plays an important part in the problem of physical deterioration. Education and preventive medicine should advance side by side. Sanitary law has its limitations; and experience shows that it is difficult to make people healthy by Act of Parliament. On the other hand, education, whether it be of mind or of body, has scarcely begun its work in England. The essentials for healthy living are few, and are based upon simple and common-sense principles. The tendency to physical degeneration can be overcome by physical education; the dangers of intemperance can be indicated by teaching, and the ravages of tuberculosis are more likely to be checked by education of public opinion than by law. Personal hygiene can be demonstrated and carried out as an educational subject. And, since the school is the recognised centre for education, therein lies the chief hope of improving the physical condition of the people.

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* *See ante*, pp. 72–75.

There are two methods of making a nation healthy, eugenics and eutrophics. The one aims at the begetting of healthy children, the other deals only with their upbringing. The former is ideal, and will not be practised in England for many years to come, for it implies the regulation of marriage. But, in process of time, education will teach men generally to consider a woman's bill of health, in addition to her other qualities, before proposing marriage. Meanwhile our salvation lies in eutrophic principles.

Tuberculosis is an insidious disease common to man and some animals. Its prevalence is a result of civilisation; and, though its mortality rate has been steadily declining for half a century, still one-seventh of the population of the civilised world dies of tuberculosis. In England and Wales nearly 40,000 people die of tuberculosis every year; and one-third of all deaths between 20 and 40 years of age are due to this cause. And yet tuberculosis is a preventible disease. In most respects, it is analogous to leprosy, and could be stamped out of England in a generation (1) if the sanitary control of milk and meat supplies were strictly enforced, (2) if all patients, in the first stage of the disease, were given the opportunity of open-air treatment, either at home or at a sanatorium, and (3) if all advanced and dying cases were isolated in special open-air colonies. But, as things are, such interference with the liberty of the subject would not be tolerated. So, in its ignorance, the general public is content to drink tubercular milk, to eat tubercular meat, and to marry tubercular wives or husbands.

Though there appears to be some tendency to fresh legislation as to the supervision and control of milk and meat supplies, yet the central authority has taken no serious steps to check the disease, and local sanitary authorities (with a few noticeable exceptions) have confined their attention to the prevention of spitting and other such half-measures. If the problem is to be faced rationally, there are two essentials to secure. One is the education of public opinion, and the other the establishment of a Central Board responsible to a Minister of Public Health.* Every nurse should use her utmost endeavours to educate public opinion. It is true legislation as to marriage and as to segregation would be difficult to enforce ; and much latitude would be necessary. But the educational value of even a few weeks' open-air treatment for all early cases is beyond dispute. And no man or woman who has had tuberculosis should venture to marry before consulting a medical practitioner. The segregation of advanced and dying cases in more appropriate places than the Poor Law infirmaries should not prove an insuperable difficulty.

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* Since these remarks were written there has fortunately been a general awakening of a sanitary conscience with regard to tuberculosis. The National

Tuberculosis exists in many different forms—pleurisy, hip-disease, meningitis, lupus, spinal disease, peritonitis, swelling of glands, abscesses, and finally pulmonary tuberculosis, or consumption.

Methods of infection.—These various manifestations are all caused by the entrance of the tubercle bacillus into the human body. It is, therefore, an infectious disease, though not in the same degree as smallpox or diphtheria. There is no exact knowledge as to how the disease is "caught," nor as to what is the length of the incubation period. Some cases no doubt become infected by swallowing tubercle bacilli in milk or in meat ; but, generally speaking, the bacillus is inhaled in the air we breathe. The presence of the bacillus in rooms and houses occupied by consumptive patients can readily be demonstrated—even for some considerable time after their occupation—if strict precautions as to cleanliness and ventilation have not been observed during their tenancy. The disease has thus been proved to be "endemic" in certain houses and localities—a fact which has been confirmed to an almost incredible degree by some recent investigations in Paris.

Individual susceptibility.—Apart from these various methods of infection, the susceptibility of the individual is a factor of prime importance. Either the soil—so to speak—is suitable for the growth of the bacillus, inasmuch as it does not withstand the invasion, or the natural resisting powers of the individual are sufficient to overcome the bacillus and

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Association for the Prevention of Consumption has been doing pioneer work for many years. In 1909 notification of phthisis was made compulsory in the case of "poor persons," and in 1911 the obligation was extended to the community generally. Some local authorities have established tuberculosis dispensaries, and the Education authorities of London, Bradford, Sheffield, etc., have instituted open-air schools for delicate and invalid children—an example that has been followed by the establishment of special schools for tuberculosis and the holding of outdoor classes at many country schools. Provision has now been made, under the Insurance Act, for the erection of sanatoria for the reception of tuberculous patients.

its poisons. This process represents a struggle—extending, it may be, over months and years—during which there is perhaps no obvious sign of the disease. In other words, tuberculosis may be latent. But, in view of the frequent exposure of almost every individual to the possibility of infection, and in view of conclusive *post-mortem* evidence to the effect that the disease is frequently arrested in its early stages, man cannot be regarded as very susceptible to the infection. At all events, susceptibility depends upon certain predisposing causes, such as heredity, deficient vitality, improper breathing (due to malformation of chest, obstruction by enlarged tonsils and adenoid growths, or to breathing impure air), want of exercise, lack of food, intemperance, etc.

Preventive measures.—Attention must therefore be directed to diminishing the danger both of individual susceptibility and of accidental infection. There is always a danger in the dried sputum of consumptive patients, but so there is in their coughing, sneezing, loud talking, etc. Spitting is an objectionable habit, and should be discouraged in all covered places and vehicles. The common alternatives to spitting are equally objectionable; spittoons should therefore be provided in public places. But it should be remembered that the decreasing mortality rate of tuberculosis is not entirely—nor even largely—due to the prevention of spitting, but rather to the better ventilation and increased air-space of dwellings and institutions, and also to the improved conditions of life. Smallpox was not brought under control by preventing the aërial convection of the contagium, but by making people insusceptible and by compulsory notification and isolation. The analogy is not exact, but it is logical. As long as there are any susceptible people and any infectious cases, so long will both diseases tend to spread. *Voluntary notification* proved itself difficult in practice, and was only to be regarded as a stepping-stone to compulsory notification—the way for which was prepared by the L.G.B. Order which made the notification of phthisis compulsory in the case of "poor persons" and of all patients treated in public institutions. Now, as mentioned on the preceding page, pulmonary tuberculosis ranks among notifiable diseases.

Summary.—Briefly, then, tuberculosis may be kept under control by diminishing the number of susceptible individuals, by early diagnosis, notification, and treatment of all cases in the preliminary stages, and by the isolation of advanced cases. It is the duty of the general practitioner and of the "school doctor" to increase the resisting powers of susceptible persons, and to detect early cases. It is the duty of nurses and health visitors to become acquainted with the early symptoms of the disease, and to teach how infection may be avoided and predisposing causes overcome. Education authorities should provide open-air schools or out-of-door classes for susceptible and debilitated children. Lastly, it is the duty of nurses, and of all who have the opportunity, to educate public opinion as to the elementary facts of this great national problem. Now that tuberculosis has become notifiable, and Parliament has provided funds for the establishment of sanatoria at which tuberculous patients can be treated as soon as the disease is diagnosed, we may hope that the problem is well on the road to solution.

Alcoholism.—Immoderate drinking, or intemperance, lowers the natural powers of resistance of the human body, and prepares the way for many diseases. The truth of this statement is attested daily in the medical wards of a general hospital. The Report of the Inter-Departmental Committee on Physical Deterioration pointed out that " the abuse of alcoholic stimulants is largely responsible for physical deterioration," that " the children of intemperate parents are seriously affected " in their predisposition to disease ; and that " the increase in lunacy is largely due to intemperance." Alcoholism has already been mentioned as an important predisposing cause of tuberculosis, which is a very common disease among innkeepers, potmen, and brewers. The dangers of intemperance should be taught in the schools, and nurses should take their part in educating public opinion, since, at the present time, drunkenness is popularly regarded as a laughable and a trivial offence.*

Syphilis is a specific, infective disease, either acquired by inoculation or inherited from an infected parent. It is common in all classes of society, but among the poor it is often untreated. Herein lies a great public danger. Possibly the disease cannot be prevented by law ; but district nurses and health visitors can perform a useful public service by making themselves acquainted with the early symptoms of the disease, by impressing upon female patients the necessity for obtaining immediate and prolonged treatment, and by urging the importance of cleanliness. It is, generally, a disease of immorality ; but it is not the province of a practitioner or of a nurse to act as judge in this matter, but rather to ensure the immediate treatment of the malady. Tact and knowledge are essential. It sometimes happens that patients refuse or avoid treatment. The result is that the disease tends to increase rather than to decrease, and thus acts as a very serious cause in undermining the health of the nation.

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* The Board of Education has recently issued a Syllabus on the Teaching of Temperance and Hygiene in public elementary schools.

Infantile mortality involves the problem of death from all causes during the first year of life. The "infant mortality rate" is represented by the proportion of deaths under one year of age to every 1,000 registered births. The rate is very high in European countries, and in spite of the great advance in general hygiene and sanitation, it is not declining. In England the rate varies from 120 to 180. That means that, out of every 1,000 children born, 180 die before they are twelve months old; and more than 100,000 of these infants die every year in England. If, in this way, only the weak and sickly children were killed off, the problem would be serious enough. But frequently the strongest and the healthiest babies succumb, while many of the survivors are handicapped from the outset by the very same evil influences. The study of the problem is complicated, but to Sir George Newman, now the Chief Medical Officer of the Board of Education, we owe its elucidation. His views may here be briefly summarised.

Causes.—Infant mortality is chiefly a problem of town life—the result of increased density of population and of certain industrial and social conditions. During the first three months of life, death is generally due to prematurity and immaturity, and after this period, epidemic diarrhœa and inflammatory diseases of the lungs account for the greatest mortality. But there has been no tendency for the number of deaths from these causes to decrease. Prematurity and immaturity, apart from specific and accidental causes, appear to be chiefly due to the ill-nourished and wretched physical condition of many mothers during pregnancy. These evil effects are enhanced by their employment in factories, which, in turn, exerts a bad influence on the home life. Domestic and social conditions, therefore, are important, chiefly owing to negligence and ignorance on the part of mothers, and to the general thriftlessness—or worse—of the home. "The suitable feeding of infants is of vital importance. It is not everything, but it is a greater factor than any other single thing. The problem of infant mortality is, after all, one of those elementary problems which depend more upon instinct and the physical faculties and functions which nature has provided in the mother than upon external environment." Many of the factors are of importance only because they do not fulfil "the primitive needs of food, warmth, and cleanliness."

Prevention.—Preventive measures concern the mother, the child, and their environment. "A higher standard of physical motherhood is the first requirement." Charitable agencies for the feeding of nursing mothers deal only with one symptom of the problem. Mothers must be educated as to the management of infants, and girls should be taught the principles of domestic economy and hygiene in the schools.* Nurses and health visitors must instil into parents a sense of their duties and responsibilities towards their infant children, and must point out the importance of cleanliness and sanitation in the home. An attempt to deal with the problem in the borough of St. Pancras has resulted in the establishment of a "School for Mothers" upon the lines of a similar institution in Ghent.

Some mothers are unable to suckle their children. Then the difficulties of artificial feeding begin. Municipal milk depots have done something to solve one special difficulty, in so far as the control of milk supplies and the supervision of infant feeding are concerned.

Medical inspection of schools now forms an integral factor in every modern system of education, and, in this way, it has a direct bearing upon the physical condition of the people. School hygiene aims at the mental, moral and physical improvement of the children, at the prevention of disease in childhood, and at the gradual development of a science of education. Meanwhile a single branch of the subject has been imposed as a duty upon local education authorities by Act of Parliament—namely, the inspection of children in the school. It must be remembered, however, that this is only the initial step in a great scheme of progress.

The administrative medical officer responsible for the School Medical Service is styled the School Medical Officer, and it is his duty to report annually to his Authority and to the Board of Education. In many areas there are also Assistant Medical Officers, school nurses, attendance officers, and voluntary workers. Local Education authorities have the power also of making arrangements, subject to the approval of the Board of Education, for treating defects disclosed by the inspection, in school clinics and in other ways.

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* The Board of Education has recently issued a Memorandum on the Teaching of Infant Care and Management in Public Elementary Schools.

Duties of the school nurse.—The duties devolving upon the school nurse are—

(1) To assist the doctor at the admission examinations.

(2) To be responsible for the supervision of the personal hygiene and cleanliness of the children, under the direction of the doctor.

(3) To recognise ringworm, favus, scabies, and other contagious conditions.

(4) To recognise the commoner external eye diseases, such as "blight," corneal ulceration, conjunctivitis, ophthalmia, etc.

(5) To advise the teachers in regard to the exclusion of doubtful cases of infectious and contagious disease.

(6) To help the teachers, if necessary, in weighing and measuring the children, where any system of anthropometry is introduced; and also to supervise the primary sight-testing which should be undertaken by teachers.

In certain specified cases, and under the direction of the "school doctor," the nurse may be required to visit the homes in order to advise parents in regard to their children's health. In country areas this work of "following up" is best undertaken by district nurses. In some districts it is expedient that the school nurse should also undertake the duties of attendance officer.

The whole question of "treatment at school" is under consideration, but there is little doubt that school clinics will undergo great development. In that work the school nurse is sure to play an important part.

BOOK III.—THE PRACTICE OF NURSING

CHAPTER XVII

PERSONAL HYGIENE FOR NURSES

BY WM. CECIL BOSANQUET, M.A., M.D.(OXON), F.R.C.P.

Habits of Punctuality and Neatness—Avoidance of Undue Worry—Rest and Sleep—Change of Occupation—Cultivation of Outdoor Amusements—Eating and Drinking—Alcohol—Outer Clothing—Condition of the Skin—The Daily Bath—Attention to the Hair and Underclothing—Care of the Nails and Teeth—Infectious Cases—How to Avoid Infection.

IN no profession is the careful preservation of bodily health more important than in that of nursing, for the nurse is brought into more constant and intimate contact with disease than is even the doctor, whose visits are momentary compared with her constant attendance, while the nature of her duties renders necessary qualities of patience, self-control, and evenness of temper which can only be satisfactorily maintained by one whose physical powers are equal to all the demands made upon them. Temper and disposition are largely matters of health, and an attack of indigestion or neuralgia will go far towards neutralising the virtues fostered by the smartest training and the kindliest disposition. Further, the nurse must be herself an example of obedience to those rules which she has constantly to be inculcating upon her patient. In no province of life is it more true that example is better than precept, for the public give nurses credit for greater knowledge than they themselves possess on all matters connected with health and disease, and a nurse living in a household can do much to influence the ideas of a wide circle of those with whom she is brought into contact.

Under the heading of personal hygiene—the art of taking care of one's own health—must be considered such apparently small matters as habits of punctuality and neatness, cleanliness, eating and drinking, rest and exercise, and clothing, as well as the avoidance of infection when nursing cases of infectious disease. The value of **habits of punctuality and neatness** from the patient's point of view is emphasised in another chapter; but for the nurse's own benefit they are equally indispensable. It is most important for her own health that her meals, for example, should be regularly taken, with sufficient time for their proper consumption; and this cannot be the case if her work is not so adjusted as to leave her free at the proper times. In hospitals and similar institutions this is arranged for by the regulations of the place, but in nursing private cases the same punctuality is needed, and without it much unnecessary trouble is caused in a household, friction is produced, and it becomes impossible to ensure punctuality in others when it is most needed. So, too, with habits of neatness: they are insisted upon in hospital, but they should become second nature and be kept up as carefully in private work. From the patient's point of view they are important, but they are just as useful to the nurse. An infected instrument left lying about may cause a dangerous wound; a thermometer put down and forgotten may result in much loss of time and trial of temper; and often the smaller troubles of life cause more annoyance than its greater evils.

Here we would allude to a point which may not at first sight appear to bear upon hygiene, and that is the importance of **avoiding any tendency to worry over cases unduly**—to be continually examining oneself as to the possibility of sins of omission or commission, and fretting over apparent failures in the struggle against disease. The beginner especially is liable to suffer from harmful anxiety, and to take to heart the loss of a case or the occurrence of some complication, regarding it as a proof of some fault on her own part. She is apt also to feel that directly her back is turned some unforeseen evil may befall the patient, and that she cannot therefore leave the bedside for any length of time, however much she herself may need rest and relaxation. Experience, as a rule, does away with this tendency to worry, but individuals differ in temperament; some appear never quite to lose it. In view of this tendency it is well to bear in mind that the utmost which nursing and medical aid can accomplish in severe cases of disease is very little. In only a few conditions where specific remedies are known (as, for example, quinine for malaria) can we be said to *cure* disease; as a rule, we can only aid the patient in his struggle by putting him under favourable conditions, and if his powers of resistance are defective no treatment can avail.

It is sad and discouraging to lose a case of enteric fever or pneumonia in spite of every care and attention ; but the consciousness that everything possible has been done should be sufficient consolation and should prevent any tendency to worry over such a fatality and to indulge in useless self-accusation on account of it. Nor should the very praiseworthy desire to do everything possible for a patient lead the nurse to the neglect of her own health. From time to time even the experienced, such as charge nurses and ward sisters, may be found refusing to take their proper time off duty when there is some serious case under their care. Once in a way, in some specially critical emergency, this may be right, but to do it often is unfair both to herself and to her other patients, as she needs the most complete health and energy for the due discharge of her ordinary duties, and should not endanger herself and others by any violation of the laws of health.

The subject of **rest and sleep** is an important one to the nurse, for patients and their friends often seem to think that nurses have some special faculty which enables them to do without much rest, and have little consideration in the demands that they make upon her by rousing her at all hours. It is also often very difficult for night nurses to secure proper quiet for sleep in the daytime owing to the noises around them. Hence they should have assigned to them, if possible, rooms which are at the backs of houses in a town, so as to be free from the noise of the street, and in country houses such rooms as are most likely to be quiet in the daytime. Individuals differ somewhat in their need for sleep. Our ancestors laid down the rule, "Six hours for a man, seven for a woman, and eight for a fool," but they lived in less strenuous times than we do, and the fool's allowance is none too much for most busy persons. Sleep is the great opportunity for the cells of the body, and especially of the brain, to build up again the substance which has been broken down in the activities of the day. The beat of the heart and the rhythm of respiration are slowed, but the processes by which the cells take up food materials from the blood and convert them into living protoplasm are in full swing. It has been suggested on this account that it is even more important that a plentiful supply of fresh air should be available during sleep than in the day, in order to ensure that no poisonous products of respiration should be reabsorbed ; at any rate, such fresh air is very important at night, and open windows should be the invariable rule. A good example is thus set to others.

There can be no doubt that by a fresh-air life the tendency to colds and minor ailments, as well as to consumption, is greatly lessened. At the same time it must be remembered that the temperature of the body is lowered during sleep, and that it is necessary to provide for due warmth by a sufficiency of bedclothes. Chilling of the body is never wise, and must be carefully avoided. A sufficient interval should elapse between the last solid meal and bedtime—not less than two hours—otherwise sleeplessness may result, or uneasy, disturbed sleep.

A word of caution may here be said against the use of narcotic drugs for sleeplessness. All of them are dangerous and they tend to produce a habit of taking them which is difficult to break, and which necessitates the use of constantly increasing doses. Sleeplessness results very often from indigestion, which must be treated by appropriate measures; or it may be induced by lack of exercise in the open air. In some persons cold feet seem to produce wakefulness, and a hot-water bottle is a useful soporific. Sometimes half an hour's reading of some light literature, such as a novel, is of assistance, or a cupful of hot milk taken at bedtime.

But rest may be obtained also by **change of occupation.** Certain groups of cells become tired out by particular forms of work, while others are doing nothing and remain fresh. If, then, by a change of occupation the latter are brought into play while the former are idle, the best results are obtained. After mental work, outdoor exercise serves to secure this form of relaxation, and in a less degree mere change of subject serves the same purpose. Hence arises the value of having a hobby of some kind, so that other trains of thought are taken up and no time is left for continuing the anxieties of the sick-room when the hours of duty are over. A taste for reading, for collecting stamps or autographs, any absorbing pursuit, in short, is of value as a means of turning the thoughts into a new channel and relaxing the stress of constant attention to the same subjects.

But far better is the cultivation of some *outdoor amusement*, for thus the need for regular bodily exercise in the fresh air will be ensured. Cycling is nearly always possible, and is a valuable means of obtaining exercise in the open air with a moderate amount of exertion, while it facilitates the covering of much greater distances than can be done on foot, so that it is easier to avoid monotony of scenery. Apart from this last advantage—and it is a great one, as mental interest is thus added to mere exercise of muscle—walking is probably quite as good a form of exercise. Still better is some active game, such as lawn-tennis, which brings the arms as well as the legs into play and adds the interest of rivalry. Unfortunately, it is only occasionally available for nurses. One special form of exercise may be mentioned, as, though it may perhaps be looked upon as unduly childish, it has the merit of being particularly useful as a remedy for a minor ailment to which nurses are somewhat liable, flat-foot: this is skipping. Apart from congenital defects, flat-foot is largely due to standing about for long periods at a time, and unfortunately there is a tendency in hospitals to insist upon an unnecessary amount of standing in the wards. It is better to sit down when not moving actively about, as standing throws a stress upon the ligaments of the foot without calling in the muscles to assist them in supporting the weight of the body. It is important, as a remedy for this condition when it has started, and better still as a preventive, to strengthen the muscles of the calf, and skipping is a very useful exercise for this purpose.

It may be well to point out that exercise should not, as a rule, be taken to the point of producing fatigue. Anything approaching exhaustion is absolutely harmful, and such forms of exertion as cycling up-hill are to be avoided. One should come in refreshed by exercise, not tired.

The effect of exercise is, in the first place, to increase the tissue-changes in the muscles of the limbs; owing to this there is a demand for more food-material to take the place of that which is used up, and the appetite is correspondingly increased. The respiration is stimulated and the chest caused to expand more freely, and any tendency to tubercular disease of the lungs is thus combated. The movements of the intestines are also, it would seem, influenced, for exercise is one of the most valuable factors in the treatment of constipation. The circulation is quickened and the heart kept in good order, like the other muscles: the skin is flushed with blood, the glands in it are stimulated to act, and troubles such as chilblains, which arise from defective circulation in the extremities, are prevented.

Exercise should not be taken immediately after a solid meal, as the blood is then needed for the processes of digestion, and the vessels of the alimentary canal are full, while the blood is drawn away from the surface and limbs. Exercise at such a time tends to upset this arrangement, and indigestion may result.

This may be a convenient point at which to emphasise the importance of regularity in the action of the bowels as one of the fundamental necessities of a healthy state. A daily evacuation is generally to be insisted upon, though it must be admitted that persons differ somewhat in their needs in this respect as in others. Custom has ordained the time immediately after breakfast as the most convenient for this purpose, and this time has the advantage that the peristaltic action of the bowels which persists during sleep has had time to force a considerable quantity of refuse material into the lower part of the large intestine, while the stimulus provided by the taking of food at the morning meal helps to set in action the mechanism of expulsion. Habit has, however, much to do with this last factor, the desire for evacuation of the bowels tending to recur at the time at which it has generally been gratified. If irregular habits are permitted, this factor is liable to disappear and further irregularity is encouraged; while the longer the act is deferred the more difficult is it likely to become. A state of chronic constipation is easily induced, and with it those sequels, such as anæmia, foul tongue and breath, and lassitude, which are produced by the absorption of poisonous materials from the colon. Appendicitis and other serious disorders are almost certainly predisposed to by habitual constipation.

Not much need be said as to **eating and drinking.** It must be borne in mind that a good supply of food is necessary for a busy life, and a nurse must resist any tendency to scamp her own meals through over-anxiety to get back to her patient. In most hospitals there has been an improvement in the diet allowed for the nurses in recent years; it is now generally wholesome, though often unappetisingly served. In rate-supported institutions there would seem to be, as a rule, little cause for complaint. It is to be hoped that the tendency which formerly existed in some of the charitable hospitals to economise unduly in this direction has now disappeared. On the other hand, it can scarcely be doubted that as a nation we consume in this country an undue amount of meat, and that most people would benefit by cutting down their daily supply. Nitrogenous food is only needed to make good the actual waste of living tissue, and this is not increased by ordinary work, the energy for which is derived probably from the carbohydrates consumed. A nurse should not go on duty without taking some food—if possible, a solid breakfast. If this be impossible, then at least a cup of cocoa or tea and a slice of bread-and-butter should be eaten. Work done fasting is unduly exhausting.

A word may be said as to *alcoholic drinks.* While much nonsense has been written as to the harmful effects of even moderate indulgence in such beverages, it can hardly be denied that they are unnecessary for the great majority of healthy persons. Taken in the middle of the day, they are liable to cause a feeling of sleepiness and disinclination for exertion. Taken in the evening by those whose work is over, they are less harmful, but they must never be indulged in between meals. Alcohol supplies a temporary whip to a tired body, and may enable a little more work to be done for a short time ; but the effect soon wears off and leaves a greater feeling of exhaustion. The temptation to dispel this by renewed doses of the stimulant constitutes one of the great dangers of the original indulgence. The amount of alcohol contained in different forms of drink varies greatly ; thus, in beer there is not usually more than 5 per cent., in spirits there may be over 50 per cent., and in wine various quantities between these extremes. Those who are accustomed to a glass of beer with their meals need not feel that they are taking anything pernicious, though it may be borne in mind that it gives an unpleasant odour to the breath for some little time afterwards.

A word of caution against excessive use of tea may be added. In some countries it is said that tea-drinking is carried to such excess that a form of intoxication due to the alkaloid present in tea (theine or caffeine) is produced. In our own country the danger lies rather in digestive disturbances due to the astringent matter of the infusion. Tea should never be allowed to stand long to "brew." Five minutes should be the outside time that the water should be allowed to stand on the leaves. Both tea and coffee are liable to produce sleeplessness, if taken too near to bedtime. For the same reason coffee is a good drink for those on night duty, if they find it difficult to keep awake.

A nurse's **outer clothing** is prescribed by custom—a cotton uniform, apron, and cuffs. The colour of the dress should be light, as it is desirable that stains should be at once visible, so that it may be promptly sent to the wash when soiled. It should not be highly starched, as a disagreeable amount of rustling is thus produced, and a nurse should move about as silently as possible. The dress should be short enough to clear the ground freely. It should fit comfortably, so as to leave the muscles free to move without impediment, and anything approaching to tight-lacing must be carefully avoided. Tight corsets impede the action of the lower ribs, press deleteriously upon the stomach and impede digestion, and tend to produce serious displacement of the abdominal organs. Cotton not being a warm material, it is the more necessary in the cold seasons to wear warm underclothing beneath it. The warmth of a material depends chiefly upon the amount of air which it contains among its fibres, and the advantage of woollen garments depends upon this quality, for air being a non-conductor of heat, materials which hold it in their meshes have the same property. A non-conductor is needed in order that the skin may be kept at an equable temperature and not exposed to sudden loss of heat which may result in a chill. Clothes should also admit of a fair amount of ventilation, as the surface of the body is constantly giving off moisture even when no actual perspiration is perceptible. Hence it is undesirable to remain for any length of time in a mackintosh, which is impervious to moisture and consequently unhealthy. If such a garment is necessary, as in very wet weather, it should be ventilated in a suitable manner, as by the provision of a cape beneath which the outer air can reach the arms and body of the wearer. In hot weather or after exertion, when the skin has perspired freely so as to render the underclothing damp, it is advisable to cool oneself as gradually as possible, so as to avoid any tendency to chill, not sitting in a perceptible draught, for example, and avoiding any sensation of chilliness. The danger popularly associated with wet feet resides in the chilling of the extremities which results if wet stockings are not changed ; there is, of course, no special risk in the actual wetting of the feet while they are kept warm by exercise.

Attention to the **condition of the skin** is of much importance in relation to the preservation of health. Two kinds of glands open on the surface of the skin, the sweat-glands, which are in the form of coiled tubes with long ducts and which secrete a watery fluid, the sweat or perspiration ; and the sebaceous glands, which give rise to an oily secretion, useful probably in maintaining the elasticity of the skin. Water alone will wash away the matter which is left by the evaporation of the sweat, but soap is needed to remove sebaceous material. In some persons the quality of the secretions is such that bacteria are able to establish themselves on the skin and to give rise to offensive products, especially in the axillæ and on the feet. In such cases, not only careful washing with soap and water, but the use of some antiseptic is indicated to remove the offending germs. Medical advice should be sought as to treatment. Unfortunately, sometimes the sufferers are unaware of their infirmity.

For ordinary purposes of cleanliness a **daily bath** should be taken, wherever it is possible; indeed, in an occupation such as nursing, in which there is continual contact with disease, it should be regarded as indispensable. A tepid bath may be taken all the year round (75°-85° F.). Hot baths in the morning are not desirable, as they tend to create a feeling of slackness, but a quickly-taken warm bath followed by a sponge-down with cool water is beneficial. Cold baths are not to be recommended to many people in the winter, when the temperature of the water will very likely be only 35°-40° F. In the summer they are refreshing, but not good for purposes of ablution, as they are necessarily taken quickly. For ordinary use plain white soap is as good as anything, but there are many "toilet" varieties of excellent character. The hair need not be washed with soap so often as other parts of the body: if this is done too frequently, it may get unpleasantly dry. It should be kept as neat as possible, not only for appearance sake, but for more important reasons. A stray lock of hair getting over the eyes at a critical moment may cause an irritating waste of time, and may be a source even of danger if it be replaced when the hand should be kept aseptic.

Nurses who attend the poor in their homes, as in district and maternity work, will need to be especially careful in **attending to their hair and underclothing**. Both head- and body-lice are easily contracted, and the former are difficult to eradicate from long hair. It is desirable that a nurse should change her outer clothes in a separate room on coming in from her work, or, at all events, leave them outside her door; and she must minutely inspect her under-garments when she takes them off at night. The hair should be carefully combed with a small-toothed comb not less than twice a week—every night, if possible. Body-lice live chiefly in the clothes, and are easily got rid of by a change of underwear and a warm bath. If any nits should, in spite of precautions, be found in the hair, the individual hairs to which they are attached should be cut off and burnt, while careful combing will generally succeed in eradicating the parent insects.

The **nails** must be kept carefully cut level with the finger-tips. They should not be cut down to the "quick," as such treatment tends to make them separate further down from the matrix, and their shape is thus spoiled. Nor should they be allowed to grow long, as then they are liable to break down below the "quick" and to cause trouble. They should be cleaned as far as possible with a nail-brush, rather than with any sharp instrument, as injury to the finger is thus avoided. "Hang-nails" or trifling abrasions round the nails must be carefully attended to, as they are liable to act as points of infection and to lead to whitlows.

Neglect of the **teeth** is inexcusable. From an æsthetic point of view nothing looks worse than discoloured teeth, while the presence of decaying stumps gives the breath a disgusting odour. The aid of the dentist should be sought early to stop cavities, and much suffering from toothache will then be avoided. For cleaning the teeth a soapy application is useful: a preparation containing chlorate of potash, called "Pebecol," is also a useful dentifrice. Gritty powders, such as chalk, should only be used occasionally, when needed.

In **nursing cases of infectious disease** special care must be taken to avoid, as far as possible, the risk of catching the malady. In many diseases, such as measles, scarlet fever, or mumps, the infective agent, a germ of some kind, has not yet been discovered, and hence the exact way in which it leaves the body to infect a second person is not certainly known. Possibly it may be by the breath in some instances; in others, such as diphtheria, it is undoubtedly expelled in particles of mucus from the throat and mouth. A nurse should then be careful not to hang over a patient unnecessarily, and should specially avoid allowing him to cough over her. Should this accidentally occur, she should, as soon as possible, wash her face and gargle her mouth with some antiseptic (dilute Condy's fluid, boracic acid solution, chlorine water). Free ventilation of the patient's room is most desirable from the nurse's point of view, as she is compelled to be with the patient so constantly, and in at least one disease, typhus fever, it seems to have been definitely proved that a free supply of air almost does away with risk of contagion. It is probably the same in other maladies. Children who are ill must not be kissed.

A nurse must not take her meals in the patient's room, and must insist on having them elsewhere if any difficulty is raised. She must, of course, be careful to wash her hands invariably before eating. It is well also to clean the teeth before meals, and the mouth and throat may be gargled several times a day with some antiseptic as a matter of routine.

In enteric fever the infection is definitely derived from the excretions of the patient, and rules as to disinfection are given in the section dealing with this disease. It must be borne in mind that the urine is infectious as well as the fæces. In tuberculosis of the lungs the sputum must be carefully destroyed, and in cases of urinary infection care must be taken to render the urine innocuous. With reasonable care there is no danger in nursing cases of tuberculosis, and the nurse can reassure the friends of such patients, who are often nervous of infection, pointing out that a phthisical patient is not a source of danger if care be taken in the disposal of the expectoration.

In nursing fever cases the nurse should, if possible, secure a room near to the sick-room, in which she can change her dress before going out. She should go straight out of doors without mixing with the members of the household. If preferred, she can wear a cotton overall in the sick-room and take it off on going out instead of changing her dress. It is desirable that visitors to an infectious patient should also put on some form of overall in the patient's room, and leave it behind when they get outside.

In nursing septic (suppurative) cases, syphilitic persons, and others, great care must be taken not to get the hands infected. A careful lookout should be kept for the slightest abrasions, cuts, scratches, and chaps on the hands, and if any such are found they must be carefully covered up with collodion or some other suitable substance. The possibility of carrying infection to the eye must be remembered, and all temptation to rub the eyes should be resisted. Should they itch or be inflamed, they should be well bathed several times a day with cold boracic lotion. In applying remedies to cavities such as the rectum or vagina in infectious conditions, the use of rubber gloves is very desirable. The use of these at operations where it is necessary to keep dabbling in strong antiseptic solutions will prevent roughness of the skin and sore fingers, as well as affording an additional aid in keeping instruments, etc., free from contamination.

Germs cannot enter by the unbroken skin, and if introduced into the stomach many varieties are rendered practically innocuous by the acid gastric juice. The pharynx is, however, probably a frequent seat of infection. Any tendency to sore throat, adenoid growths, or enlarged tonsils should receive medical attention. Breathing through the mouth is harmful, and every attempt should be made to maintain a good habit of nasal breathing.

After all, the most important factor in avoiding infection is the *maintenance of good general health* in accordance with the suggestions which have been given above and with all other principles of common-sense. An instance is quoted in which two medical students frequented the wards of a fever hospital for several weeks without catching any disease ; but one day they entered the wards when tired out with exertion, and both contracted scarlet fever in a severe form, one of them actually dying of it. The resistance offered by the healthy body to disease is broken down by ill-health, deficient food, or over-exertion, and the germs of infection then readily gain a footing. When good health is maintained, any germs which enter are promptly destroyed by the leucocytes and the fluids of the body.

CHAPTER XVIII

SYMPTOMS AND SIGNS OF DISEASE AS OBSERVED BY THE NURSE

By Wm. Cecil Bosanquet

Distinction between Symptoms and Signs—Attitude—Movements—Mental Condition—Face and Expression—Eyes—Ears—Nose—Tongue—Teeth—Skull—Neck—Breathing—Voice—Speech—Cough—Sputum—Difficulty in Swallowing—Vomiting—Limbs—Joints—Hands—Feet—Gait—Chest — Abdomen — Back—Motions—Urine—Temperature—Pulse—The Sphygmographic Curve—Convulsions—Sleep—Jaundice—Headache.

The symptoms and signs of disease are the manifestations by which we recognise that a person is ill—in other words, that he or she is not in the perfect exercise of all the natural functions of the body. A distinction is sometimes drawn between symptoms (Greek, *symptōma*, a coincidence) and signs, in that the former are perceptible to the patient and are complained of by him, whereas the latter are discovered by others who examine him. Thus a headache is a symptom in this sense, while a cardiac murmur is a sign. But many phenomena of disease are perceptible to both patient and doctor ; thus, a cough is both a symptom and a sign, and a strict adherence to the distinction would leave only pain and abnormal sensations of other kinds to be classed as symptoms, all other manifestations of disease being signs. Such a classification is clearly useless, and for practical purposes we may use the terms as identical.

Symptoms and signs, then, are the means by which we recognise disease. We cannot, for example, in a living person *see* that part of one lung is inflamed and consolidated—that he is suffering from pneumonia ; but experience shows that if a patient has during life suffered from rapid breathing, pain in the side, and high fever, and has also brought up rusty tenacious sputum, there will be found after death the lung-condition just mentioned. These then are the signs and symptoms of pneumonia, as they can be observed by a nurse or anyone else unprovided with special instruments, and unskilled in medical methods of examination. Further signs are revealed by percussing the chest, and by listening to the sounds formed within it on breathing or speaking ; but these need not be described here, where only those things which a nurse can observe for herself will be considered.

Theoretically, symptoms may be classified into two groups, although at present we do not know enough about disease to be able to make a distinction in all cases. Thus some arise from the actual disease, and represent the alterations in the functions of an affected organ ; while others represent the attempt made by the living body to expel irritating materials or to counteract their effects. An example will make this clearer : The bleeding from a wound or the albumen that appears in the urine in nephritis are directly due to the injury, the tissues being torn in the former case and letting the blood escape, and the kidney being injured in the latter, and acting as an imperfect filter. On the other hand, the cough which troubles a patient suffering from bronchitis is an effort to expel the secretion which is blocking the bronchial tubes ; and probably the redness and swelling of an inflamed part, due to increased flow of blood in it, represent an attempt to neutralise the poisons of invading bacteria and to supply leucocytes and chemical substances to oppose the aggressors. It is important to realise this distinction, as it is dangerous to try to suppress a symptom which represents a defence of the body. For example, to check the cough in bronchitis with opium is to run the risk of killing the patient by suffocating him with the secretion which the cough is calculated to expel. Similarly, the diarrhœa which may occur in a uræmic patient is useful as carrying off by means of the bowel some of the poison which is at work, and it is dangerous to check it.

Attitude.—Much may be learnt from observation of the attitude assumed by a patient, in bed or out of it. One who lies naturally in bed and changes from one position to another freely, is probably not suffering from any severe or exhausting disease. On the other hand, a sufferer may be so weak as to be incapable of maintaining his position and may sink down in the bed, lying helplessly in whatever posture he is put ; this indicates an extreme degree of bodily weakness, and may be seen in the later stages of severe febrile diseases, such as enteric fever.

As a rule, patients who are gravely ill lie on their backs, and have to be propped up on one or other side, if this is desirable for nursing purposes. In some painful conditions of the chest or abdomen, however, there is a tendency to lie constantly on one or other side, for relief of the pain. Thus, in acute pleurisy, the sufferer may either lie on the affected side at first, in order to keep it from moving as far as possible—the pain being due to the rubbing together of the two inflamed surfaces of the pleura, one on the lung, the other lining the chest-wall—or he may find that the pressure thus produced aggravates the pain, and may prefer to lie on the sound side or on his back. In cases in which there is large effusion of fluid within the pleural cavity, the patient generally lies on the affected side, as by this means he allows the sound lung freer movement, the lung on the side of the effusion being compressed by it and rendered useless for breathing. If there is much difficulty in breathing, the patient often cannot lie down in bed, but has to be propped up with pillows or a bed-rest ; this condition (orthopnœa) is often seen in cases of severe bronchitis, pericarditis, or heart-disease. In some instances (pericarditis, aneurysm) the patient leans forward, resting the head and arms, if possible, on a table or other support.

In cases of acute peritonitis the sufferer generally lies in bed on his back with the knees continually drawn up, and often with the hands clasped over the head, in order to render the abdominal walls as immobile as possible, and thus lessen the pain. If only one leg be drawn up, a hint may be given of the existence of inflammatory trouble on that side of the abdomen only, as in appendicitis or one-sided pelvic inflammation.

In the condition known as cerebral irritation, which may follow injuries or accompany various cerebral diseases, the patient lies in bed "curled up," with his legs and arms bent, resenting any attempt to straighten him out or turn him over, and promptly curling up again and burying his face in the bedclothes when disturbed. If the membranes covering the brain be inflamed (meningitis) there is often rigidity of the muscles of the neck, and the head may be bent backwards by the spasm. An exaggeration of this condition is seen in some cases of chronic meningitis in young children, the whole body being bent backwards so that the head and heels are almost in contact. In poisoning by strychnine, violent spasms of all the muscles occur, and the body of the patient may be arched backwards or sideways, rarely forwards.

In severe abdominal pain the sufferer tends to double himself up and press his hand on the abdomen. In cases of angina pectoris—severe cardiac pain—the patient who may be moving about at the time of its onset, tends to stop suddenly in whatever attitude he may be in, making no movement of any kind, owing to fear that the least exertion may be fatal. Sufferers from heart-failure often prefer to sit in an arm-chair, rather than lie in bed.

Movements.—The movements of a patient may be quite characteristic of his disease ; thus the sudden purposeless jerky movements of a choreic child are quite distinctive. So, too, are the position and movements of a sufferer from paralysis agitans (shaking palsy) ; he sits with the head bent forwards, one or both hands constantly moving with a tremulous twitching motion, as if he were rolling crumbs of bread between his thumb and fingers ; there may be nodding of the head at the same time. The restless movements of an actively delirious or maniacal patient are too well known to need description. In other forms of delirium the patient may be constantly moving his hands restlessly about, as if picking straws off the bed or catching at particles floating in the air ; this is a sign of severe poisoning of the nervous system by some disease, such as enteric fever, and is consequently of evil omen, though not necessarily fatal. Sometimes, on feeling the pulse of a patient in this condition, a twitching of the tendons at the wrist may be perceived (subsultus tendinum) without actual motion of the fingers. Tremor of the hands is met with in old persons, in drunkards, in certain disorders of the nervous system, and in severe febrile conditions—in these last it is a grave sign.

The **mental condition** of a patient is of importance to observe. He may be dull and take little notice of what is going on around him, as in some forms of brain disease, in severe fevers, and in some cases of poisoning. This dull condition may be still deeper and a condition of insensibility or coma be reached, when it is impossible to rouse the patient by the voice, however loud, or by other forms of stimulation. Coma is met with in drunkenness and other forms of poisoning (opium, belladonna, etc.), in cases of cerebral disease (tumours, meningitis), in apoplexy (cerebral hæmorrhage and allied conditions), in renal disease (uræmia), and as a termination of diabetes. On the other hand, the mental state may be one of excitement (mania), of irritability, or of nervousness ; and illusions (false interpretation of impressions) and hallucinations (hearing voices or seeing sights which have no external objects to excite the sensations) are met with in the insane. Delusions that the patient is being persecuted, that he has committed some unpardonable sin or crime, or that he has some incurable disease, are important as possibly pointing to a condition of melancholia, in which the sufferer may make attempts at suicide. They should be reported to the doctor at once. Attempts at suicide may be made by patients suffering from delirium tremens, and consequently such patients must never be left alone.

Face and expression.—The face is a useful index of disease, and may give warning that a patient is doing badly even when definite signs are wanting elsewhere. The flushed face of fever is well known; and the pale circle round the mouth, with flushed cheeks and forehead, is very characteristic of scarlet fever. The *pallor* of anæmia can hardly fail to strike the attention, but may accompany more serious conditions, such as tuberculosis or renal disease, as well as the simple anæmia of young women. In grave forms of anæmia, such as pernicious anæmia, the face may have a slightly yellow tinge. The deeper yellow of *jaundice* is also seen in the face, and appears early on the sclerotics (whites of the eyes), where it also lingers late. Puffiness of the face, especially beneath the eyes, is very suggestive of renal disease.

Cyanosis, or blueness, indicates as a rule deficient aëration of the blood, due either to failure of the heart or to obstruction in the respiratory apparatus (bronchitis, laryngeal obstruction). Infants who are the subjects of congenital malformations of the heart may present this blue colour at birth and maintain it throughout life. In cases of difficult respiration, as in pneumonia and pericarditis, the nostrils (alæ nasi) may be seen to dilate at each inspiration.

The condition of the face seen in those who are dying of acute abdominal disease or of some exhausting illness was described many hundred years ago by the old Greek physician, Hippocrates, and is still called after him the *Hippocratic face*: the nose looks pinched, the cheeks sunken, the eyes hollow, the ears thin; there is a dusky pallor and sometimes sweating. In patients who suffer from headache there is often a frown on the forehead, as if to shut out some of the light from the eyes. Deep lines on the forehead are also seen in melancholic patients, who wear an aspect of intense dejection. An *anxious* expression is observable in those who are suffering from grave illness, especially heart-affections and abdominal disease; in the latter there is often an exaggeration of the fold which runs from the nostril to the corner of the mouth (naso-labial fold). This is very well marked as a rule in infants who suffer from diarrhœa and vomiting. The wizened, monkey-like faces of "wasting" children are often very striking; many of them are the subjects of congenital syphilis.

Small dilated veins on the cheeks are often present in alcoholic subjects; also in those who suffer from chronic bronchitis. Redness of the nose is not always alcoholic in origin; it may arise from indigestion, and often accompanies tight-lacing. In drunkards and others, nodular masses of fatty tissue may occur on the nose and cause great deformity.

Various *rashes* and *skin diseases* affect the face: thus the exanthemata of measles, chicken-pox, and small-pox appear there; syphilitic affections often appear on the forehead; and herpes round the mouth often accompanies infective diseases, such as a common cold, pneumonia, cerebro-spinal meningitis, etc. *Lupus*, a tubercular disease of the skin, oftenest attacks the face, and may spread inside the nose and cause much destruction of tissue; it is a disease of young persons. In the elderly another affection, *rodent ulcer*, may occur, often starting at the inner corner of the eye or on the cheek, and causing much disfigurement and finally death, if not removed in an early stage.

Paralysis of the face (Bell's palsy) is not uncommon; the affected side of the face is flat and motionless, and the eye on that side cannot be closed, but rolls upwards beneath the eyelid when the patient makes an attempt to shut it. The mouth is drawn up on the sound side, if the patient tries to smile or show his teeth, and food accumulates in the cheek in the process of eating. In cases of hemiplegia, in which the arm and leg are paralysed on one side of the body, the lower part of the face is generally affected on the same side.

The eyes.—In wasting diseases the eyes appear sunken into their sockets; rarely, in certain nervous affections, one eye may be sunken and the other normal. The possibility of a patient's wearing a glass eye should be borne in mind when one eye looks different from the other. Very prominent eyes are suggestive of the affection known as Graves's disease or exophthalmic goitre; nervousness, flushing, tremor, palpitation, and enlargement of the thyroid gland are the other chief symptoms of this disorder.

Conjunctivitis—inflammation of the conjunctiva—shown by general redness of the white part of the eye, often occurs, and is assigned by patients to a draught; it is probably due in most cases to the entrance of some infective germ. It is not generally serious, but in newly-born babies may be due to gonorrhœal infection and result in blindness. Hence the recognition of the condition is most important in maternity work.

Pain in the eye and fixity of the pupil may indicate iritis; the *iris* generally looks muddy and its markings are blurred.

Unequal pupils are met with in aneurysm of the aorta, owing to irritation of the sympathetic nerves, and in some cerebral disorders. In children the pupils are often very large; in old people they may be contracted. Persons with little pigment in the iris usually have small pupils. Greatly contracted pupils ("pin-point pupils") are seen in poisoning by opium, and in some cases of cerebral hæmorrhage. Widely dilated pupils on the other hand may result from cerebral compression or from poisoning by belladonna. Cocaine also dilates the pupils, as does homatropine, the drug usually employed for dilating them artificially for purposes of examination.

Sometimes *opacities* (nebulæ) are visible in the *cornea*, due to old ulcers; in severe cases they may cause blindness. A ring of opacity is often seen just within the outer margin of the cornea in old persons, either partially or entirely surrounding the eye (arcus senilis). In those who are the subjects of cataract the opaque lens may be seen through the pupil as a whitish body, instead of the usual black orifice.

Squint (strabismus) occurs when one or more of the muscles which move the eye are paralysed. In recent and mild cases the patient complains of seeing double; in old-standing cases he generally learns to disregard the image formed by one eye, and uses only the other, thus avoiding the evils of double vision (diplopia). A continual oscillation of the eyeball (*nystagmus*) occurs in some persons; it may be congenital, or occur in those who have become blind in infancy, or it may result from disease.

The *eyelids* may be the seat of inflammation, chiefly along their margins (blepharitis); or they may be the seats of inflamed glands (styes) or cysts (Meibomian).

Transitory attacks of *blindness* may occur in patients who suffer from renal disease, and are a symptom of uræmia. The occurrence of gradually increasing dimness of sight may be of importance as a sign of the occurrence of optic neuritis (inflammation or œdema of the optic nerve). A suddenly-occurring blindness in one eye may be due to embolism (blocking) of the central artery supplying the retina; it may occur in cases of heart-disease. Patients are often unconscious of the existence of blindness in one eye, owing to the fact that they always use both eyes together; they may only discover the blindness accidentally on closing the sound eye, and may think that the defect has suddenly occurred, whereas it may have been there for many years. *Specks* floating before the eyes are usually a sign of general weakness or anæmia, and are not of much importance. Patients who suffer from sick headache (megrim) may complain of seeing *coloured circles* and *zigzags* at the beginning of their attacks.

The ear.—It is often of great importance to recognise the existence of a *discharge* from the ear. This may be so slight as to escape the notice of the patient, but may leave traces on the pillow or be visible on looking into the ear. *Earache* in infants may only be betrayed by their crying and putting their hands to their ears. Sometimes the inflammation of the ear which causes the pain may produce alarming symptoms, such as convulsions and retraction of the head, which disappear when the pus which has formed in the ear is allowed to escape. Temporary *deafness* is not uncommon in enteric fever, and may also result from the administration of salicylate of sodium or of quinine. *Tenderness* over the mastoid process (Fig. 1., Vol. I., p. 179) is important as a sign of extension of suppuration from the middle ear.

The nose.—*Bleeding* from the nose may occur at the onset of infective diseases, especially enteric fever. At other times it may be due to renal disease with high blood-pressure—and here it may have a safety-valve action—or to heart-disease; or it may result from some local lesion in the nose itself. Blood derived from the nose may be swallowed and brought up again, thus simulating hæmatemesis. A *discharge* from one nostril occurring in a child may be due to some foreign body such as a bean or cherry-stone pushed up the nostril. Obstruction in the nose, as by adenoid growths, gives rise to mouth-breathing and many resulting troubles.

The tongue.—Much may be learned from the study of the tongue in disease. A *furred* tongue generally indicates the existence of some catarrh of the stomach and alimentary canal, in which the tongue shares; it is marked in cases of gastritis and gastric carcinoma; it also occurs in fevers, in renal affections, and in many other conditions. The thickness of the coat of "fur" is some measure of the amount of disturbance, but

Sideboard	$ 5.
Settee	6
Side Stand	2
Washstand	4
Bedstead	5.
Carpet	—
Table	3

some persons normally have rather "white" tongues. In rheumatic fever a very thick white fur is common. In other severe febrile disorders the fur tends to assume a brown colour, especially if the mouth is also dry; while saliva, particles of food, and scales of epithelium may become caked on the teeth and lips (*sordes*). Local disease of the mouth or tonsils may also give rise to a furred tongue.

A *dry* tongue is often of serious import in infective diseases; it seems to indicate a profound degree of poisoning. In scarlet fever the tongue is at first thickly coated, but soon peels and presents a red appearance with prominent papillæ, its aspect being compared with that of a *strawberry*. In diabetes the tongue may look large and fleshy, "like raw beef." In some other affections it is large, pale and flabby, marked at the edges with dents where it has pressed against the teeth. *Cracks* and *fissures* may be visible on its surface, and *ulcers* of various kinds occur at its sides, more rarely on the tip or the dorsum.

When the tongue is protruded, it may be seen to be *tremulous*, especially in alcoholic subjects and general paralytics; fine twitching movements of individual fibres in it (fibrillary twitching) occurs in some nervous diseases, generally along with some wasting of the muscle of the organ. The tongue may be *protruded to one or other side*, instead of in the middle line, in those conditions which are accompanied by paralysis of the lingual muscles (hemiplegia, etc.). Since the tongue is pushed out by pairs of muscles acting symmetrically on the two sides of it, if either side is weakened the tongue will deviate towards the affected side.

Tenderness and swelling of the **gums** round the teeth, with some bleeding, accompanied by foul breath and tongue, is characteristic of scurvy. It may occur in infants who are brought up on artificial foods.

The teeth.—In infants late appearance of the teeth is an indication of rickets; it is important to ascertain therefore how many are present and to compare the number with what should be found at different months. A child of one year should have at least eight teeth fully erupted. The process of teething is blamed by mothers for many infantile troubles, but has really little to do with most of them. In adults a sound and perfect set of teeth is very rare; in hospital patients the teeth are often allowed to get into a very foul condition, and infection of the gums, round the necks of the teeth, with the organisms of suppuration is very common. Some physicians believe that this condition may give rise to gastric and other troubles; it is certainly unhealthy and disgusting.

It may be important to ascertain whether a patient wears artificial teeth, as, for example, before he takes an anæsthetic. They should be removed from the mouth of an unconscious patient, if the plate is a small one which could easily pass down the throat.

The skull.—In infants an examination of the skull is important. *Bosses* or knobs on the bones may indicate rickets or congenital syphilis, and these diseases may also produce a *thinning* of the bones, giving rise to a curious sensation of elasticity beneath the pressure of the finger (craniotabes, or wasting of the skull). The *anterior fontanelle* should close at about eighteen months or two years of age ; delay in closure or abnormal size of the orifice is an indication of rickets. If the skin over the fontanelle is seen to bulge, there is increase of pressure within the cranium, probably due to meningitis ; if, on the other hand, the skin here is depressed, the infant is probably in an exhausted condition, due to diarrhœa, starvation, or some other wasting disease.

Great *enlargement* of the head occurs in hydrocephalus (water on the brain), in which it may be possible to feel that the bones of the skull are actually pushed apart by the pressure from within. The eyes in such cases may be pressed downwards in their sockets, so that the lower eyelid crosses the middle of the cornea.

The presence of *lice* (pediculi) in the **scalp** is very common among children and not rare among adult women of the lower classes. The nits or eggs are visible as minute white bodies glued to the hairs. Sores on the scalp in children are generally caused by the scratching induced by these insects, and enlarged glands in the neck may result from septic absorption from the sores.

Patches of baldness in the scalp in a child are probably due to *ringworm ;* in an adult they may result from an apparently non-infective disease, called alopecia areata. In the latter case the skin is smooth and polished, instead of being rough and scaly as in ringworm.

In the **neck**, the presence of *enlarged glands* is perhaps the commonest morbid condition ; scars may be seen where inflamed glands have burst through the skin or have been incised surgically. The scar of an old tracheotomy wound may also be noted. Enlargement of the *thyroid* gland produces fulness at the root of the neck, slight degrees of which are sometimes considered a beauty ; great enlargement of this gland constitutes goitre. Marked pulsation of the vessels in the neck may be seen in cases of heart-disease, especially aortic regurgitation.

Stiffness of the neck may be a simple rheumatic affection, but in a child it may also indicate more serious disease—caries of the spine or commencing meningitis; the retracted condition of the neck-muscles which occurs later in meningitis has already been mentioned. Congenital *wryneck* (torticollis) is generally due to some affection of one or other sterno-mastoid muscle (Plate XI., Vol. I.).

In conditions of obstruction of the air-passages, as in diphtheria, there may be sucking-in of the soft parts at the root of the neck, above the clavicles, with each inspiratory effort. *Œdema* of the neck may be caused by blocking of the great veins in the chest (vena cava or innominata).

The breathing.—The normal rate of breathing is from fifteen to twenty times in a minute, or, roughly, one inspiration to every four beats of the pulse. *Rapid* breathing is usually a sign of some difficulty in the process of respiration. In acute pneumonia rapid and rather shallow breathing is the rule, the amount of lung-tissue available for respiration being diminished owing to the consolidation of the lung. Probably, however, the poisons of the disease act also on the respiratory centre, and on the nerves supplying the lungs. In bronchitis the breathing may be rapid owing to the obstruction caused by mucus in the bronchi. Exertion also quickens the rapidity of the breathing, as does nervousness in some cases.

Slow breathing is noticeable in some cerebral affections, as in compression of the brain. A peculiar condition known as *Cheyne-Stokes* breathing, in which there is a gradual fall in the amplitude of the respiratory movements until they entirely cease for a few seconds, followed by a succession of gradually increasing efforts, is occasionally observed, especially in cerebral and in some cardiac cases. *Shallow* breathing, in which only slight movements of the thorax are made, and thus small quantities of air are drawn into the chest at each inspiration, is often due to pain in respiration, as in pleurisy, the patient instinctively avoiding any free movement of the chest-walls. In dyspnœa the movements may be deep as well as rapid; a special condition of dyspnœa in which very full inspirations are taken is the so-called "air-hunger" of diabetic coma.

A rough hissing or roaring noise (*stridor*) audible in both inspiration and expiration indicates obstruction in some part of the air-passages, as in diphtheria, where the larynx is obstructed by false membrane, or in aneurysm of the aorta when there is pressure of the sac on the trachea or on one of the bronchi. A sudden attack of dyspnœa with stridor occurring in a child may be due to impaction of some foreign body, such as a coin, in the larynx. When there is mucus in the bronchial tubes, a *rattling noise* may be heard as the patient breathes ; the so-called "death-rattle" is due to the accumulation in the throat of a dying person of mucus which cannot be coughed up. *Stertorous* or snoring breathing may occur in comatose patients, as in sleep, owing to the relaxed condition of the soft palate, which vibrates with the current of air. Patients suffering from pneumonia often give vent to a *grunting noise* with each expiration. The *short piercing cry* uttered from time to time by some sufferers from meningitis is a peculiar and somewhat distressing feature of the disease.

The breath may *smell* offensive owing to the presence of decaying teeth or of enlarged tonsils, or the accumulation of sordes in the mouth. Alcoholic patients and sufferers from indigestion often have fœtid breath. A most nauseating odour is present in the breath of those who are the subjects of gangrene of the lung or of bronchiectasis, due in the former case to putrefaction of the dead lung-tissue, in the latter to decomposition of secretion retained in dilated bronchial tubes. The breath of diabetic patients may have a sweet smell due to the presence of acetone. It is said that in certain diseases the bodies of patients exhale a characteristic odour—for example, that those who have nursed cases of typhus fever can recognise the presence of the disease in other patients by the "mousy" smell.

The **voice** may be entirely absent (*aphonia*), only a whisper being possible; in some instances this is an hysterical manifestation, but it may also be due to advanced disease of the vocal cords (tuberculosis, cancer). In less grave cases the voice is *husky* or *hoarse*, as in simple catarrhal laryngitis, and in some cases of laryngeal paralysis (e.g. that due to aneurysm of the aorta). In very exhausting diseases the voice may become so weak as to be almost inaudible.

Various defects of **speech** may be noticed in nervous affections. Total inability to speak may be congenital, especially accompanying deafness (deaf-mutes). In some cerebral lesions speech may be lost (*aphasia*), and of this condition two varieties are distinguished—one in which the patient cannot understand what is said to him or make any attempt to reply (sensory aphasia), and the other in which he can understand what is said to him and may even be able to speak some words in answer, but the words spoken are not those which he tries to say and may be nonsense (motor aphasia). He may be unable to name common articles such as a knife or match-box correctly. In affections of the lips and tongue there is inability to *articulate* certain letters, e.g. b, p, t, the patient being unable to pronounce such words as bible, memory, etc. In the disease known as disseminated sclerosis a curious alteration of speech is met with, the patient pronouncing each word syllable by syllable in a jerky manner (*staccato* speech). In general paralysis there is indistinct stumbling speech, syllables being sometimes dropped or one word run into another; the patient has a difficulty in repeating a sentence of any length at dictation. Delirious and maniacal patients may talk to themselves incessantly, while in some forms of insanity there is a tendency to keep repeating some single phrase over and over again. *Stammering* is a defect depending on some irregularity of action in the process of forming words; it occurs chiefly in nervous persons, and is not a symptom of any serious disease.

Cough is a symptom in most diseases of the lungs and in some others. Something may be learned by noting its peculiarities in different cases. When no expectoration is brought up, the cough is often spoken of as "*dry*"; any irritation in the lungs or bronchi may produce such a condition. On the other hand, if there is much mucus in the tubes, and this is easily brought up, the cough is "*loose*." In the early stages of acute bronchitis, when there is much swelling of the bronchial mucous membrane and only a little tough mucus exudes, the cough is tight and strangling—with much effort and little result. A "*hacking*" cough is often due to irritation of the throat. In hysteria there is sometimes a loud "*barking*" cough, in which nothing is expectorated. In cases of laryngeal paralysis, as in aneurysm of the aorta, the cough is peculiar in sound, and ineffectual in character, owing to imperfect closure of the vocal cords; it is sometimes spoken of as "*brassy*" or "*clanging*," and may resemble the cough of a sheep. Absence of cough is no proof that serious disease is absent, as cases of tuberculosis of lungs are met with in which there is practically no cough throughout. In pneumonia and pleurisy the patient endeavours to check the cough as far as possible, owing to the pain which it causes.

The term "*stomach-cough*" is sometimes used to indicate a cough due to gastric disturbance, apart from pulmonary disease. The existence of a cough due to digestive disturbance alone is rather problematical: most of the cases classed under this heading are probably due to pharyngeal irritation.

In *whooping-cough* the characteristic cough is produced by the occurrence of a number of expiratory spasms rapidly following one another, by which the chest is emptied of air, succeeded by a deep inspiration while the vocal cords are still almost closed, the whoop being due to the indrawing of air through the narrow opening thus left. Severe coughing is sometimes accompanied by vomiting, apparently by reason of a reflex action carried out by the vagus nerve.

It must be remembered that cough is usually an attempt to get rid of harmful matter from the air-passages, and must not be rashly checked. It may be advisable to suppress it at night, when it adds to the patient's exhaustion by preventing sleep, but to encourage it in the daytime in order to remove secretion.

The sputum.—Attention must be paid to the expectorated matter. The tough *rusty* sputum of acute pneumonia is characteristic. In the early stages of bronchitis the sputum is scanty and tenacious, or sometimes almost watery; it may be streaked with blood. Later on, it becomes more profuse, and mucous, and still later muco-purulent, in character. Large quantities of almost pure *pus* may be brought up in some cases, as when an empyema opens into the lung. The sputum is horribly fœtid in cases of gangrene of the lung, or of bronchiectasis; in the latter condition it tends to accumulate for considerable periods during which the patient is free from cough, and is then brought up in large amount. In pulmonary tuberculosis (consumption) the expectoration is often brought up in the shape of rounded pellets, which flatten out in water or on a smooth surface into round discs, like coins (*nummulated* sputum), owing to the secretion having been moulded in some small cavity in the lung. In one form of bronchitis (fibrinous or plastic) moulds of the bronchial tubes, resembling the branches of a tree, are brought up.

Blood in the sputum (*hæmoptysis*) is not always due to consumption, though this is the commonest cause of the expectoration of large quantities of blood. Other causes of profuse hæmorrhage from the lungs are mitral disease (especially stenosis), aneurysm of the aorta, and sudden blocking of an artery in the lung ("infarction" due to embolism or thrombosis). Smaller amounts are met with in the sputum in bronchitis, pneumonia, whooping-cough, and other conditions. When blood is coughed up, it is generally frothy from mixture with air, and traces of blood occur in the sputum for some days after an attack. Traces of blood in the sputum may come from the pharynx or tonsils, or even from the gums.

Difficulty in swallowing (dysphagia) may be due to pain caused by the muscular effort or by the pressure of the food as it passes downwards. Thus in tonsillitis there is *pain* in the pharyngeal region as the food passes over the inflamed glands ; in pericarditis there is occasionally pain lower down as the bolus of food presses on the inflamed pericardium in its transit. More often there is some obstruction in the pharynx or œsophagus. In cases of *stricture* of the œsophagus there is at first a difficulty in swallowing solid food ; later on, even fluids cannot be taken. On the other hand, in the case of *paralysis* of some of the muscles of the throat, as in diphtheritic paralysis, solids are taken more easily than fluids, which tend to pass up into the nose and to return through the nostrils. *Pressure* on the œsophagus from without, as by an aneurysm or tumour in the chest, is a cause of difficulty in swallowing. In all these conditions the food is returned just as it leaves the mouth ; it is mixed with saliva and is alkaline in reaction. If, on the other hand, it has gone down into the stomach and has been vomited, it is usually acid in reaction from admixture of gastric juice. In rare cases a neurotic spasm of the œsophagus occurs, and simulates a stricture.

Vomiting may be caused by affections of the stomach or intestines, or to reflex causes, as after coughing or tickling the throat, or may be due to the action of a poison in the blood acting on the nervous system, as in uræmia. In gastric affections there is usually pain or discomfort after food is taken, and then vomiting ensues. In vomiting due to nervous causes, as in cerebral tumours, there may be no nausea or discomfort, and the vomiting has no particular relation to meals. It is important to note the frequency of the vomiting, its relation to taking food, the quantity brought up, and the character of the material ejected. In *gastric ulceration*, for example, the vomiting generally occurs within half an hour of taking food, and the pain caused by eating may be relieved by vomiting; in ulceration of the duodenum, the pain and vomiting may be delayed for three or four hours, till the food passes through the pylorus. In *cancer* of the stomach the pain is sometimes continuous, aggravated by taking food and only slightly relieved by vomiting. In *dilatation* of the stomach the patient vomits occasionally, once a day or even once in two days, and then brings up a very large quantity, more than ought to be present if the stomach had emptied itself of its contents at the usual rate. The material ejected is sour-smelling and frothy. In *obstruction of the bowel,* the patient first brings up the contents of the stomach, then bilious material, and finally the vomit becomes fæcal in character. This last is a very important characteristic to observe. In *infants* vomiting of some of the milk taken occurs as a sort of safety-valve action, whenever too large a quantity is imbibed at one feeding. Children often vomit at the onset of an *acute infective* disease; adults may do the same, but less commonly. Vomiting in the *morning,* mucus being ejected, is characteristic of gastric catarrh, often due to alcoholic habits.

The vomiting of large quantities of *blood* (*hæmatemesis*) is usually due either to gastric ulceration or to cirrhosis of the liver; in the latter case the blood may come from the veins at the lower end of the œsophagus. Some physicians now believe that in many instances of vomiting of blood in young women, there is no ulcer present in the stomach, but that an oozing of blood takes place from the mucous membrane, as it does sometimes from the nose. After hæmatemesis blood often appears in the motions, which should be carefully observed.

The limbs.—The occurrence of abnormal *movements* in the limbs, as in chorea or paralysis agitans, has already been mentioned. Absence of movement may denote paralysis; thus when the arm and leg of one side are paralysed, the patient is said to be suffering from "hemiplegia"; when the legs are both paralysed, from "paraplegia." Paralysis of individual groups of muscles may produce abnormal *positions* of feet or hands; thus, when the extensor muscles of the foot are weakened, as in peripheral neuritis, the foot drops down into a position of over-extension (*foot-drop*); if the extensors of the wrists are affected, the wrist droops when the arms are held out in a position of pronation (with the backs of the hands upwards). When one group of muscles is paralysed, those muscles which act as antagonists to them may become shortened and produce deformities by fixing the joints in abnormal positions; in this way some varieties of club-foot are produced. When the nerve going from the spinal cord to the muscles of the limb (*see* p. 33) is affected, the limb will be limp (*flaccid*); when there is some interruption of the course of the nerve-fibre from the brain to the cell in the anterior cornu of the cord, there is often rigidity (*spasticity*) of the limb. Sometimes when a spastic limb is forcibly moved, or when a patient attempts to stand on a leg thus affected, the muscles are thrown into involuntary rhythmical contractions (*clonus*). Muscles affected with flaccid paralysis waste rapidly; with spastic conditions, there is comparatively little wasting.

Paralysis is simulated in some cases by conditions in which there is pain in moving the muscles. Thus, in affections of the bones near their extremities (epiphysitis) in children, in osteomyelitis, and in infantile scurvy, in which there is effusion of blood beneath the periosteum, the limb may be motionless and apparently paralysed. In these cases, however, examination will reveal great tenderness and some swelling at the affected spot.

In affections of the *nerves* tingling and numbness are often complained of by the patient; the sensation may be compared to ants crawling over the skin. Patients who suffer from the cocaine habit may maintain that there are insects creeping beneath the skin.

Bending of the bones of the limbs is common in rickety children, in whom also the ends (epiphyses) of the long bones may be markedly enlarged. *Varicose veins* may appear on the legs as bluish knots or twisted cords; they are frequently associated with eczema or even ulceration. *Œdema* of the feet and legs occurs in heart failure, renal disease, and occasionally in anæmic conditions; it may also be due to thrombosis of veins.

In acute inflammation of a **joint** there is generally swelling and tenderness round it, and much pain on movement. The muscles which move the joint usually waste. In acute rheumatism the larger joints are generally affected, and the pains fly about from one to another; there is often little visible redness or swelling, but the pain may be very acute. In some conditions, such as acute synovitis, fluid accumulates in the cavity of the joint, and can be recognised by its elastic (fluctuating) feeling on pressure. In chronic conditions such as rheumatoid arthritis irregular outgrowths of bone take place round the joint; in the fingers spindle-shaped enlargements are seen; while the fingers themselves, instead of opening straight outwards, are pushed obliquely over towards the ulnar side of the hand, owing to enlargement of the distal ends of the metacarpal bones. In some nervous diseases a rapid degenerative affection of the joints occurs (Charcot's joint), the articular surfaces of the bones and the ligaments becoming destroyed, and bony outgrowths being formed around the joint, which is quite disorganised; spontaneous dislocation may occur. The peculiarity of the disorder is that it is quite painless.

The **hands** often give indications of the occupation of their owner; they may also point to the presence of disease. Thus in pulmonary tuberculosis and in other forms of chronic chest-disease, such as empyema, bronchiectasis, and congenital malformation of the heart, the fingers are *clubbed*, the last joints being enlarged, and the nails tending to curve over the tips of the fingers. In myxœdema the hands are broad and clumsy (spade-like). In some cases of neuritis the skin of the fingers becomes *glossy*, looking thin and tightly stretched, owing to defect in its nutrition. In the affection known as Raynaud's disease, the tips of the fingers may become white and numbed, or blue, as if frost-bitten, or may actually become gangrenous, owing to spasmodic contraction of the arteries supplying the limb; the toes may be similarly affected. In paralysis of the ulnar nerve the whole hand assumes a *claw-like* condition, the first (proximal) phalanges being bent backwards on the hand, and the other phalanges flexed. *Wasting* of the small muscles of the hand is best seen in the ball of the thumb, and along the side of the hand above the little finger.

In the **feet** various forms of deformity occur, such as the different varieties of *club-foot*, flat-foot, and hollow foot (pes cavus). Dropped foot has already been mentioned. A special form of ulceration, "perforating ulcer," is liable to occur in some nervous affections, especially locomotor ataxy, beneath the ball of the great toe. *Gout* often begins by an attack of agonising pain in the joint of the great toe. Continued pressure over this joint gives rise to enlargement, constituting a *bunion*. The great toe may be bent outwards over the other toes in the condition known as *hallux valgus*.

In some diseases the patient's **gait** is peculiar. In locomotor ataxy he tends to walk with the feet rather wide apart, and the eyes fixed on the ground, raising the feet unnecessarily high, and bringing the heels down forcibly on the ground. In cerebellar disease the gait is reeling or staggering, like that of a drunken man. Neuritis of the legs leads to drop-foot, and causes the patient in trying to walk to lift the feet high, while the foot hangs limp; it has been compared with the walk of a chicken. If there is spastic paralysis of the legs, they become rigid on attempting to walk, and may be thrown into clonus. Sometimes, if there is much spasm of the adductor muscles, the legs are crossed in walking (" scissors " gait). In paralysis agitans the patient on endeavouring to walk may break into a run, and be unable to stop himself.

The chest.—*Deformities* of the chest are common in sufferers from rickets; thus the sternum may be pushed forwards, and the sides of the chest constricted (pigeon-breast), or there may be sinking in of the ribs just above the attachment of the diaphragm. " Beading " of the ribs (rickety rosary) can be seen or felt in rickety children. In cases of spinal curvature one side of the chest may be enlarged, the other sunken. An abnormally full, rounded chest (*barrel-shaped*) is characteristic of emphysema of the lungs, and a long narrow *flat chest* of consumptive persons; in the latter the shoulder-blades tend to project backwards like wings. In emphysema the chest expands little, rising and falling rather than expanding. In cases of one-sided disease (tuberculosis, pleurisy) the affected side of the chest may be seen to move less than the other, and it may look smaller and shrunken. Occasionally, if there is fluid in the pleura, the intercostal spaces on the affected side look fuller than normal.

The *heart-beat* may be visible on the chest-wall; if it is forcible and seen over a large area, the heart is probably enlarged and is acting forcibly, as in some cases of valvular disease. If enlargement of the heart has occurred in childhood, the rib-cartilages in the præcordial region may be pushed outwards, and the chest appear to bulge in this area.

Pulsation visible in the epigastrium may indicate enlargement of the right side of the heart, as in emphysema and bronchitis; in the upper intercostal spaces on the left side it may be due to retraction of the lung, leaving the surface of the heart uncovered. Aneurysm of the aorta may give rise to a pulsating swelling in the upper part of the chest. Rarely, a neglected empyema may " point " through an intercostal space, causing a swelling which may pulsate with the beating of the heart. *Enlarged veins* are sometimes visible running over the lower part of the chest and the upper part of the abdomen; they may be due to obstruction in one of the venæ cavæ, the blood having to find its way round to the heart by other channels.

The characteristic *rashes* of almost all the acute infective diseases appear on the chest—the blotchy rash of measles, the blush of scarlet fever with closely set pink points, and the vesicles of chicken-pox and of small-pox. Dirty-brown patches of discoloration caused by the disease called tinea versicolor, due to a fungus allied to the "ringworms," are not uncommon on the chest in cases of consumption.

Pain in the lower part of the chest is often due to indigestion, which is also the commonest cause of palpitation. Pain may occur in valvular disease of the heart, and is of all degrees of intensity, from mere discomfort up to the agonising pain of angina pectoris ; but the commonest symptom of heart-trouble is shortness of breath. Pain in the upper regions of the chest is suggestive of tuberculosis of the lung ; there is often some tenderness on pressure over the intercostal spaces in such cases. The pain of acute pleurisy is very severe, stabbing in character and increased by breathing ; it is simulated by intercostal neuralgia and rheumatism. Pain in the left side is very commonly complained of by women without any other signs of disease ; it may be neuralgic. The outbreak of shingles (herpes zoster) is sometimes accompanied by acute pain ; the appearance of the characteristic groups of little vesicles—often three groups corresponding with the branches of an intercostal nerve—soon shows what is amiss.

The abdomen.—*Distension* of the abdomen may be due to obesity, to flatulence, or to ascites (fluid in the peritoneal cavity) ; in the last condition the abdomen tends to bulge laterally in the flanks. If the pressure of gas or fluid within is considerable, the umbilicus may be flattened out or even extruded. If there is any inflammation of the peritoneum, the abdominal walls are usually held *rigid and motionless ;* hence it is important to note whether the movements of the abdomen are taking place naturally or not. In chronic obstruction of the bowel, in addition to the general distension, there may be seen peristaltic movements of the gut (*vermicular movements*), especially in thin persons. *Tumours* of the abdominal viscera will give rise to swellings visible in corresponding parts. Very important is the tumour formed in the hypogastric region by a distended bladder due to retention of urine ; this may occur even in a patient who is passing some water naturally. Retention may occur not only in cases of stricture, but also in acute infective diseases (e.g. enteric fever), owing to affection of the nervous system ; also in hysterical patients.

Rupture (*hernia*) commonly occurs in the inguinal region, right or left, less often near the umbilicus. Hernia at the navel is common in infants, and generally disappears under the pressure of a pad. The existence of a rupture becomes of importance in the presence of any acute attack of abdominal pain, which may be due to strangulation (compression) of the protruding gut in the ring through which it passes. Other causes of acute pain in the abdomen are perforation of the stomach or intestine, or of an inflamed appendix, appendicitis, acute intestinal obstruction or intussusception, simple colic (spasm of the large gut), twisting of the pedicle of an ovarian cyst, ruptured extra-uterine gestation, passage of a gall-stone down the duct or of a calculus along the ureter, and the gastric crises that occur in locomotor ataxy. In almost all grave abdominal conditions vomiting is a prominent symptom. The pleuritic pain accompanying the onset of acute pneumonia is sometimes felt chiefly in the abdomen.

A *retracted* (hollow) condition of the abdomen is seen in emaciated persons, also occasionally in tubercular meningitis. Linear scars, resulting from stretching of the skin (*lineæ albicantes*), generally indicate past pregnancy.

The back.—Care of the back is of great importance, in order to avoid the formation of *bedsores.* The slightest redness over any bony point should at once cause anxiety, the sacral region being the commonest situation for this trouble (the hips, elbows, and heels are other common sites). Lateral curvature of the spine (*scoliosis*) is very common, and is generally due to weakness of muscles; antero-posterior curvature (*kyphosis* or hump-back) is caused by disease of the vertebræ, usually tubercular in nature. Stiffness in the back may be rheumatic or an early sign of more serious disease, such as caries or spinal meningitis.

Other observations.—In administering enemata the existence of *hæmorrhoids* (piles) may be discovered. The nurse should also observe whether the injection flows in easily and is retained, or whether it causes pain and is returned at once. The amount that can be injected must be noted. She must also note the occurrence of *menstruation* and the character of the flow, as well as the presence of any *vaginal discharge,* and its nature.

Attention to the character of the **motions** is indispensable. Their frequency, quantity and consistency must be noted, and the presence of mucus, blood or pus especially recorded, the motion if possible being reserved for the physician's inspection. *Constipation* is a common disorder of civilised peoples; it is favoured by soft food, which leaves little residue, by anæmia, by lack of exercise and by irregular habits. It accompanies febrile diseases, and all conditions in which there is drain of fluids by some other channel (sweating, vomiting, diuresis), and is of course marked in any condition of intestinal obstruction. *Diarrhœa* is often caused by unwholesome food, especially by decomposing substances ; it accompanies catarrh of the intestines, as in alcoholic persons, and conditions of ulceration in the gut (enteric fever, tubercular ulcers, dysentery). It may be an effort of nature to eliminate some poison, as in uræmia—indeed the diarrhœa which follows the taking of unwholesome food is remedial in character, and the first line of treatment is often the administration of a purgative to assist nature in the process of expulsion of the poison. In infants and in febrile patients on milk-diet it is important to look out for the presence of *curds of milk* in the stools, which affords an indication of failure to digest nourishment. *Gall-stones* may have to be sought for by passing the motions through a sieve under a stream of water.

Blood in the motions, if of bright-red colour, probably comes from the anus or low down in the colon ; if it escape high up in the small intestine or in the stomach, it is usually black (melæna) when it is passed, giving the stools a tarry appearance. *Worms* of various kinds may be passed by the bowel—minute thread-worms being common in children. Segments of tape-worms may be seen as separate oblong bodies or may form jointed tape-like bands some inches or even feet in length. Round worms not unlike garden worms are less common. *Pain* in defæcation is usually due to piles, or to fissures or ulcers at the anus.

The urine.—The quantity of urine passed must be carefully recorded ; also its colour and appearance, if these are at all unusual. Urine containing *blood* may be bright-red in hue if there is profuse hæmorrhage, or of a dirty smoky colour if there is but little blood present. In *jaundice* the urine may be dark-yellow or almost black, and in poisoning with carbolic acid (as after a carbolic dressing) it may be greenish or blackish in hue. *Pale* urine of low specific gravity is characteristic of chronic renal disease, but may follow copious drinking or nervous attacks. Pale urine of high specific gravity suggests the presence of sugar.

The nurse may be expected to perform the ordinary tests for blood, sugar and albumin.

To test for *blood*, a test-tube is filled to a depth of about an inch with urine, and to this are added a few drops of tincture of guaiacum, which forms on shaking a turbid mixture. Ozonic ether is then poured on to this to a depth of about half an inch, and a slight shake given to the tube. If blood is present a blue ring forms at the junction between the ozonic ether, which floats on the top, and the turbid urine below.

To test for *albumin*, a test-tube is filled three-quarters full of urine, and is then held in the flame of a spirit-lamp in such a way that heat is applied only to the uppermost inch of the fluid; the tube should be moved about in the flame, and turned round, so as to avoid cracking the glass. If albumin is present a turbidity will appear in the upper part of the urine when it reaches the boiling-point; but it is necessary to make sure that this precipitate is albumin by adding a few drops of nitric or acetic acid. If the substance causing the turbidity is albumin it will be unaffected by the acid, or the precipitate may even become denser; if, however, the turbidity is due, as it may be, to phosphates, it will disappear on addition of acid. If the urine is alkaline in reaction to start with, a few drops of acid should be added before boiling, so as to acidify it.

To test for *sugar*, a small quantity (about three-quarters of an inch deep) of the dark-blue "Fehling's solution" is placed in a test-tube and boiled; it should undergo no change—if it alters on boiling, it is bad and should be thrown away. A few drops of urine are then added, and the mixture again raised just to boiling-point; if sugar is present the blue liquid turns to a bright orange colour. If only a little sugar is contained in the urine, the colour produced may be only a greenish-yellow; in that case a little more urine may be added, and the mixture again raised to boiling-point, when a clear orange colour may result. If there is still only a greenish colour, it cannot be said for certain that sugar is present. In some cases the Fehling's solution is supplied in two bottles, one containing a pale-blue liquid, the other a white solution; in such cases equal quantities of the two solutions must be mixed together to make the dark-blue Fehling's solution needed for the test. The reaction depends on a chemical change by which the blue copper sulphate present in the solution is altered ("reduced") to red oxide of copper.

To test for *bile*, a drop or two of urine is placed on a white dish or saucer, and near to it a drop of strong nitric acid. With a glass rod the two fluids are brought into contact, when, if bile is present, a greenish colour is produced, changing to orange and red.

If pus is present in urine, this has generally a turbid appearance when it is passed, and a thick, somewhat stringy deposit forms at the bottom of the specimen-glass. If some of the deposit, or of the urine containing it, is placed in a test-tube and an equal quantity of caustic potash solution added, a jelly-like mass is produced, which may be recognised on pouring the mixture from one test-tube into another, as it falls in a slimy lump with a sort of splash.

The different deposits which occur in the urine are described in the section on Physiology (Vol. I., pp. 249–53).

Very *scanty* urine may be due to heart-failure or to pressure on the renal veins, as in ascites. It also occurs in acute inflammation of the kidney (acute nephritis), as a sequel to profuse sweating or diarrhœa, and in febrile diseases. *Suppression* of urine (no urine reaching the bladder) may be due to acute inflammation of the kidneys, to reflex congestion caused by passage of a catheter or by operations on the urinary organs, or to drain of fluid elsewhere, as in cholera or peritonitis (diarrhœa or vomiting). In hysterical patients suppression of urine very rarely occurs, retention (in the bladder) frequently. *Incontinence* of urine and fæces occurs in unconscious or partially conscious patients, in those who are suffering from profound toxæmia (poisoning) in fevers, and in certain forms of paralysis in which the sphincter muscles of the bladder and rectum are involved. Dirty habits are common in lunatics and idiots.

Pain in micturition may be due to disease of the bladder, to inflammation in the pelvis, or to local conditions in the urethra (urethritis, vascular caruncle); rarely to alterations in the urine (gravel).

Temperature.—The normal temperature of the body is usually given as 98·4° F. This corresponds very closely with the average temperature in the mouth or axilla; in the rectum it is nearly a degree higher.

Clinical *thermometers* are generally graduated from 95° to 110° of Fahrenheit's scale; this scale is obtained by dividing the interval between the freezing point (32°) and the boiling point (212°) of water into 180 equal divisions or degrees. On the clinical thermometer each degree is subdivided by smaller lines, each of which represents $\frac{1}{5}$° or ·2° F. To use the thermometer the column of mercury in the tube must be shaken down below the lowest mark on the scale. The patient is then told to open his mouth, and the bulb of the instrument is gently inserted beneath his tongue on one or other side of the mouth; he is directed to close his lips upon it, but not to bite it. If the axilla is preferred as the place for taking the temperature, it is necessary to make sure that the patient's arm is pressed against his side so as to bring the thermometer into the closest possible contact with the skin. Great gentleness is needed in passing a thermometer into the rectum.

Thermometers vary as to the time which they take to act. Some are specially quick, registering pretty accurately in half a minute, but it is better to leave them in position for a whole minute. The ordinary thermometers used in hospitals take longer, and should be left in place for at least four minutes. After use, the mercury should be shaken down again, and the instrument carefully washed in cold water. It should be kept, if possible, in some antiseptic solution, when it is in frequent use. Hot water must not be used for washing thermometers, as if the temperature is too high (over 110° F.) it will break the glass.

A *subnormal* temperature may indicate prostration or sluggish vitality. *Continued* fever points, as a rule, to the presence of some infective disease. An *intermittent* temperature with wide oscillations generally indicates infection by pyogenic (suppurative) organisms (pyæmia, ulcerative endocarditis); in the late stages of tuberculosis, and in the fourth week of enteric fever, it is probably caused by invasion of the tubercular lesions and of the typhoid ulcers respectively by germs of this nature.

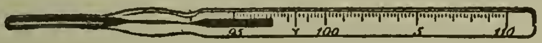

Fig. 42.—Clinical Thermometer.

A rapid rise of temperature is often accompanied by a shivering-fit (*rigor*). A sudden access of fever in a non-febrile patient usually means the *onset of some infection* (tonsillitis, influenza, pneumonia, etc.). The patient then feels shivery, if he have no actual rigor; he may complain of headache, weakness and discomfort (malaise), soreness of the throat, loss of appetite and thirst. Vomiting is not unusual, especially in children, and a general convulsion may occur in infants.

A sudden *fall* in temperature in a patient with enteric fever may indicate hæmorrhage from an intestinal ulcer or perforation of the gut. A *sudden* ending by " crisis " is common in pneumonia and typhus fever; also in the paroxysms of ague (malaria). A *gradual* decline of fever (lysis) is characteristic of enteric fever, broncho-pneumonia, and most of the other acute infective fevers.

It is well to bear in mind that patients not very unfrequently play tricks with the thermometer, so as to simulate a condition of fever; thus they may bring the bulb into contact with a fomentation, poultice or hot-water bottle, or shake the column of mercury upwards in the tube, or compress the bulb with their fingers. It is therefore advisable in all cases in which there is a curious or irregular temperature-curve to watch the patient while she (it is generally a woman, occasionally a man) is using the instrument. If the temperature is normal when the patient is watched, and rises when she is left to herself, the suspicion of fraud is very strong.

The pulse.—The normal pulse-rate is generally placed at seventy-two beats per minute in a man, and eighty in a woman. It is not at all a fixed quantity, varying with the position of the person—slower in one lying down, and greater on standing up, the difference depending on the amount of muscular effort involved. The pulse is usually felt in the radial artery at the wrist for convenience sake ; but it can be equally well taken elsewhere, as, for example, in the facial artery, as is often done by anæsthetists. The pulse is quickened by taking food, especially if alcohol is drunk ; for purpose of observation, therefore, the pulse should not be taken just after a meal.

In feeling the pulse, attention must be paid not only to its frequency but also to its regularity, force and tension. A *frequent* pulse is found in fevers, in failure of the heart, and in various nervous affections (Graves's disease, hysteria). In scarlet fever the pulse is increased in frequency out of proportion to the other symptoms ; in pneumonia the respirations are more disturbed than the pulse-rate. A slow (*infrequent*) pulse may be met with in convalescence from acute fevers, in some forms of valvular disease of the heart, and affections of the heart-muscle, and in compression of the brain ; in some persons it persists throughout life apart from disease. *Irregularity* of the pulse either in force or rhythm is indicative of failure of the heart or of some disturbance of its innervation ; it may occur in tubercular meningitis, and is common in digestive disturbances as a temporary feature. A pulse of *high tension*—one which it is difficult to obliterate by pressure with the finger—is characteristic of renal disease ; *low tension* is met with in cardiac failure, and in fevers, when the heart is weak and the vessels are dilated ; in a very low-tension pulse a dicrotic shock can be felt. In the first stage of fevers the pulse is usually full and forcible. In severe abdominal affections (peritonitis, etc.), the pulse may be very frequent, while the artery is contracted so as to feel like a cord or wire.

The normal pulse tracings, as recorded by the sphygmograph

(Fig. 43), have been illustrated in the section on Physiology (Fig. 32, p. 22). In affections of the heart the sphygmographic curve may be considerably altered. Thus in cases of cardiac failure, due to mitral disease, the beat of the pulse is feeble and irregular, and the curves formed are therefore unequal in height and have unequal spaces between them (Fig. 44). In aortic regurgitation the large volume of blood thrown into the aorta at each systole causes the height of the curve to be greater than usual; but owing to the failure of the aortic valves to retain the blood in the arteries, the fall in the pressure is immediate, and the down-stroke of the curve accordingly steep (Fig. 45); the dicrotic notch is often unusually well marked. In a pulse of high tension, owing to the maintenance of the calibre of the artery between the beats, the curve

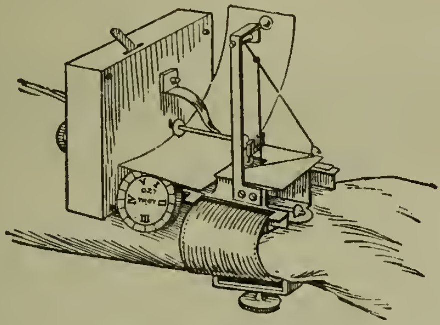

Fig. 43.—Sphygmograph.

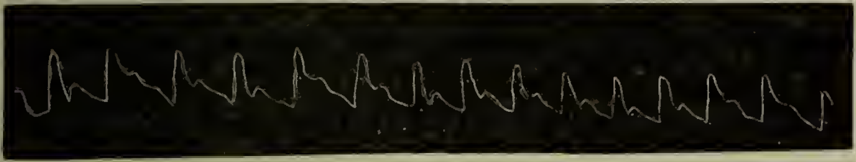

Fig. 44.—Low-tension Pulse.

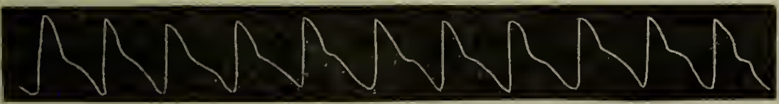

Fig. 45.—Aortic Regurgitation (Marey).

is less well developed, the depressions between the beats being shallow (Fig. 46). A dicrotic pulse gives a tracing such as is shown in Fig. 47.

Convulsions are common in *rickety* children, being brought on in them by indigestion or other trifling disturbances. They also mark the onset of *infective diseases*, and may occur in meningitis and other cerebral disorders. In adults (and also in children) they may be *epileptic* in character, or due to uræmia or to cerebral hæmorrhage. Epileptiform seizures occur in the course of some nervous disease, such as general paralysis and disseminated sclerosis. Convulsions also occur in tetanus, hydrophobia and strychnine poisoning.

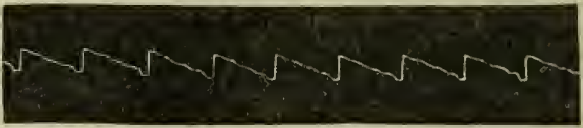

Fig. 46.—High-tension Pulse.

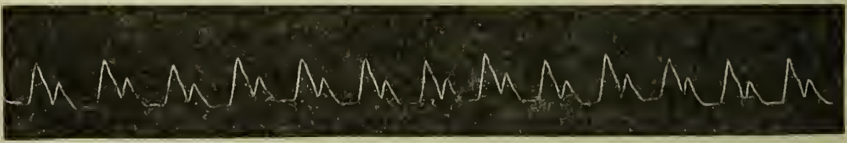

Fig. 47.—Dicrotic Pulse.

Sleep is most important for rest and repair in disease as well as in health, and it is consequently of moment to know how much sleep a patient is getting. Patients may assert and thoroughly believe that they are not sleeping at all, when as a matter of fact they get several hours of sleep throughout the night. Sleeplessness is common in acute fevers, in delirium tremens, in heart disease, and in many other affections. Indigestion, novel surroundings, anxiety, and pain are all causes of sleeplessness. A sleepy condition generally follows an epileptic fit; in the disease known as African lethargy, or sleeping sickness, the patients may remain in a sleepy condition for weeks or months before death.

Jaundice is a condition due to the entry of bile into the circulation; it may be due to obstruction of the common bile-duct by a stone or stricture, or by cancerous disease; or it may result from some form of poisoning, either by such substances as phosphorus or antimony, or by the toxines of some infective disease (yellow fever, pneumonia). A fatal disease known as acute yellow atrophy of the liver is accompanied by deep jaundice. Simple catarrhal jaundice, such as occurs in young persons, is usually ascribed to catarrh of the duodenum, causing swelling of the tissues at the orifice of the bile-duct, and consequent obstruction. Swelling of the head of the pancreas may produce the same effect. Jaundice may be accompanied by itching of the skin and by slowing of the pulse. The motions are pale owing to absence of bile, which is prevented by the obstruction from entering the intestine, while bile appears in the urine. In long-continued jaundice the patient's skin may be almost black in colour.

Headache is common in *febrile* diseases. It is very severe and continuous in *cerebral diseases*, such as tumours and meningitis; it may also be caused by *poisons* in the blood, as in uræmia. *Anæmic* persons are often troubled by headache, and *hysterical* patients suffer from a pain which they compare to a nail being driven into the head. *Affections of the eyes* are another common cause of headache, children often suffering from this symptom owing to errors of refraction.

CHAPTER XIX.

PRACTICAL DETAILS OF NURSING

By Annie McIntosh

Aspect of Sick-Room—Temperature of Room—Ventilation—Bedstead and Bed—Lifting the Patient—Undressing Accident Cases—Bathing and Washing the Patient in Bed—The Bath—Cleaning Teeth—Dirty Heads—The Bed-pan—Bedsores—Hot-Water Tins—Feeding the Patient—Sleep—Bandages—Strapping—Application of Cold—Sponging—Cold Pack—Ice Bags—Leiter's Tubes—Application of Heat—Fomentations—Poultices—Mustard Plasters—Counter-Irritation—Surgical Dressings—Care of Surgical Instruments—Taking the Temperature—The Pulse—Respiration—Enemata—Nutrient Enemata—Washing Out the Stomach—The Urine—Passing the Catheter—Washing Out the Bladder—Vaginal Injections—Hypodermic Injections—Serum Injections—Hæmorrhage—Transfusion—Administration of Medicines—Inhalation—Absorption—Suppositories—Laying out the Dead.

Aspect of sick-room.—A patient's surroundings play a great part in his comfort and well-being. If possible, a bright, cheerful room, with a south or south-west aspect, should be chosen. If the room is large and airy, with good windows, so much the better.

Temperature of room.—A room thermometer should be hung up over the patient's bed, and should frequently be consulted. Generally speaking, in the case of a medical patient, the room should be kept at a temperature of about 65° F.; and in the case of a surgical patient, of about 60° F.

Ventilation.—The bed should be placed in such a position that the room can be well ventilated without inconvenience to the patient.

It is not good for the bedstead to be directly between the fireplace and the window, but it is still more inconvenient if it is between the window and the door, especially if the room is small.

The general rule is to have the window open at the top, to make up a good fire, and to have the door closed.

When the doctor is about to examine the patient, or he is to be washed, or a wound is to be dressed, the window should be shut, but it must be opened again afterwards.

It is a good plan to open the window occasionally top and bottom for a few minutes, in order to freshen the room. The patient should then be thoroughly well protected with extra blankets and hot-water tins, and a small shawl wrapped round the head. Some people have a great prejudice against fresh air when they are ill; but if the nurse uses a little tact and discretion, the sick-room can be kept perfectly ventilated and fresh, much to the benefit of her patient.

Making up the fire.—In making up the fire, care should be taken to do so as quietly as possible. It is a good plan for each lump of coal to be wrapped up in newspaper before being brought to the sick-room. The nurse should have a large glove which she can slip on, and then she can use her hands for placing the coal on the fire. If a stick is used instead of a poker the fire can be stirred much more quietly.

Bedstead and bed.—Bedsteads should be made of iron or of brass. They should not be wide, as from a nursing point of view it is most difficult to attend to the patient comfortably if he is on a large bedstead. If the room is large enough, it is a good plan to have two small bedsteads, of the same height, and then the patient can be moved from the one to the other.

It is found to be more convenient in a hospital to have rather high bedsteads. Those in use in the London Hospital are twenty-seven inches high, without the mattresses, and the nurses find them far less fatiguing than the lower bedsteads formerly in use there.

For patients who are allowed to get in and out of bed, it will be less tiring for them if they have a bedstead no higher than a sofa.

The bedstead should be made with chain springs, and these springs should be fitted into iron, not wood. The chain spring with a hair mattress has been proved to be a very satisfactory and comfortable arrangement.

The bedstead should never be placed with one side against a wall, except temporarily to keep a delirious patient in bed.

If the bed can be placed so that the patient can see out of the window, so much the better; but it should never be placed so that the patient is directly facing the light. The light should, if possible, fall fully but crosswise on the bed, except in some cases where it is necessary for the patient to be kept with his back to the light, as is the case in most head injuries.

The nurse should remember to shade the lamp carefully at night, so that it is not shining into the patient's face—indeed the whole bed should be kept in shadow as much as possible, in order to induce sleep.

Water bed.—In some cases a water bed is ordered. It is first necessary to see that the bedstead is thoroughly strong, for a water bed is very heavy. If it has a spring mattress, it must be made rigid by planks of wood being laid across the springs. On this should be placed a level hair mattress, and the *empty* water bed on the top.

The water bed should then be filled quite full with tepid water. If sufficient water is not put in the patient is apt to complain of a feeling of sea-sickness.

Before the patient is placed on the bed one thin blanket should be stretched tightly and smoothly over the water bed, then a long mackintosh sheet, over which is placed the linen sheet and the draw-sheet.

In nursing helpless patients it is very necessary to remember that the weight of the bedclothes is often a source of great discomfort to various parts of the body. This is notably so over the toes and the abdomen. This discomfort may be removed by placing a small " cradle " between the patient and the bedclothes. In this case the patient should be protected by a small light blanket next to him.

In nursing a case of fracture of one of the lower limbs, it is necessary for that part of the body to be kept absolutely at rest. This is partly done by the aid of splints, but it is also imperative that the part of the bed upon which the lower limbs rest should be quite rigid. In the case of a spring mattress this may be effected by placing boards under the part affected, and leaving the rest of the bed so that the patient can have the benefit of the spring mattress.

Making the bed.—The great object to be borne in mind in bed-making is that of saving the patient all unnecessary pain and fatigue. When the bed is going to be made, a chair or something suitable to throw the bedclothes over should be placed near the bed for the purpose. All the top bedclothes should be removed except the sheet or one blanket which is retained as a covering. Untuck the draw-sheet and the under sheet all round.

If the patient can be with safety turned on his side, he is rolled gently over, the nurse on the opposite side of the bed supporting him in that position. The draw-sheet and under sheet are then quickly rolled up lengthwise into a roll close to the patient's back. The clean bottom sheet is tucked in lengthwise and spread quite smoothly to meet the roll of dirty sheet, the remainder of the clean sheet being rolled up similarly. The clean draw-sheet is tucked in and also rolled up to the patient's back. The patient is then gently rolled on to the other side, the nurse on that side of the bed supporting him. The other nurse quickly removes the soiled sheets and unrolls the clean sheet, tucking it in firmly all round, and being careful that it is perfectly smooth and without the slightest crease or wrinkle. The draw-sheet is also unrolled and tucked in tightly. The patient is then rolled back gently into the middle of the bed. His head and shoulders should be supported while the other nurse removes the pillow. This should be well shaken away from the bed to avoid shaking up the patient at the same time. It is replaced with the cool side uppermost.

The two nurses should then lift the patient a little higher in the bed, as there is always a tendency to slip down.

A clean top sheet should be spread over the soiled one covering the patient, which can then be easily withdrawn to the foot of the bed. The top sheet should not be tucked in at the bottom of the bed, but folded neatly back over the blankets in those cases where the bedclothes will have to be turned back in that way for the doctor, and back upon itself in those cases where the blankets can be tucked in at the bottom of the bed. This leaves the end of the sheet smooth instead of crumpled.

If the blankets are rather long, the extra part should be turned over or tucked in at the foot, to avoid the extra weight over the chest. The corners of the blanket at the top of the bed should be neatly folded over to prevent it from dragging on the floor.

The counterpane should not be too heavy. In the summer a clean sheet makes a good substitute for a quilt, and is very light and cool.

In some cases it is more convenient in changing the bottom sheet for the soiled and clean sheets to be rolled from the bottom towards the top of the bed, instead of lengthwise from side to side. In cases of fracture of the lower limbs, for instance, the sheets are usually changed by this method.

Every accident bed should be made up with a mackintosh and draw-sheet.

A blanket should never be put on the mattress under the patient unless specially ordered. If a patient has to lie between blankets one should be placed *over* the bottom sheet, and the top sheet should be put *over* the blankets and next the counterpane, in order that the bed may have a neat and clean appearance.

Care should be taken that the top bedclothes are not too heavy. This is a frequent source of restlessness, and a point which may be easily rectified.

Sometimes after certain operations, as vaginal hysterectomy, the surgeon prefers the bed so to be made that the top bedclothes open in the middle. For this method two top sheets and two top blankets are required. The sheets are folded in half, and also the blankets, which are placed inside the sheets. They are then so placed that they meet in the middle of the bed. The quilt is now spread right over the bed, making it quite neat. There is generally a cradle used in these cases to take off the weight of the clothes (Fig. 48), and then a small light blanket is placed next the patient. There is also a firm pillow wrapped in a draw-sheet and placed under the patient's knees to relax the abdominal muscles, and usually there is a square water pillow placed under the draw-sheet beneath the patient's buttocks.

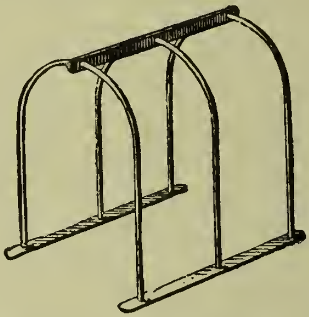

Fig. 48.—Cradle for Supporting Bedclothes.

Pillows.—Much care and trouble are required in arranging a patient's pillows. Individual tastes have to be consulted, but it is always well to have the shoulders sufficiently supported, and not to have the head poked forward. If a patient is more or less sitting up supported by pillows it must be seen that the bottom of the back is well supported with a firm pillow placed low down, and the same applies in fixing bed-rests. These may be of various kinds. Perhaps the iron ones, the height of which

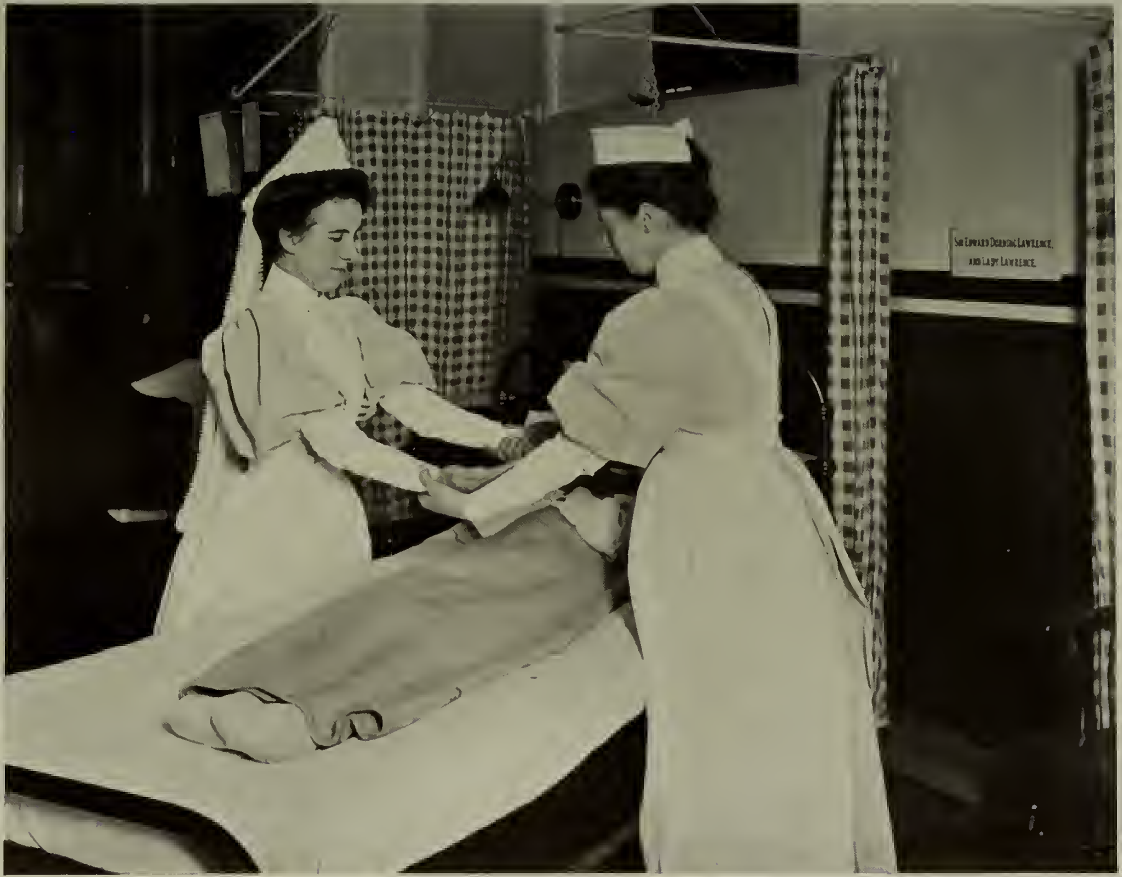

PLATE XXVII.—POSITION OF HANDS IN LIFTING A PATIENT (LONDON HOSPITAL).

can be regulated, are the most satisfactory all round. The pillows must be arranged to suit the patient, but the bottom of the back must be well supported.

A patient who is sitting up with a bed-rest often finds it a great comfort to have his arms supported on small pillows—sometimes, too, he likes a pillow placed under his knees. If this pillow is rolled in a sheet, and the ends are tied up to the top of the bedstead, it materially helps in preventing the patient from slipping down in bed. There is a great tendency to do this when propped up.

In turning a patient on his side, it is best to turn him well over, and then gently draw the buttocks towards the side of the bed, flex the knees a little, and place a firm pillow lengthwise in the small of the back, so that he feels the comfort of its support.

Lifting the patient.—In lifting a patient there should be two nurses, and in some cases three or four. A nurse stands on each side of the bed. They place their hands well under the patient's back at the waist, and their other hands just below the buttocks. The taller nurse grasps the wrists of the shorter nurse, who places her hands out straight—palms uppermost (Plate XXVII.). The patient is then told to cross her arms over her chest, and to put her head forward. It is now quite easy to raise her into the required position (Plate XXVIII.). If the patient is very weak and ill, a third nurse will be required to support the head and shoulders, and if the patient must be kept absolutely flat and have as little movement as possible, a fourth nurse should lift the legs.

Undressing accident cases.—There are a few points which it is useful for a nurse to know in connection with the undressing of accident cases, in order that the patient may be saved unnecessary pain and that the extent of the injury may not be increased.

An old blanket should be placed over the bottom sheet, the top bedclothes having all been removed.

The patient should then be placed on the bed. His boots should be first removed as gently as possible, taking care to hold the leg firmly, so that there may be no jarring.

All the buttons of coat, waistcoat and shirt should be undone, not forgetting the wristbands of the shirt. The braces should be unbuttoned in the front, and the nurse should place her hand under the back and undo them without disturbing the patient.

If one of the arms has been severely injured, it will probably be necessary to cut the coat sleeve up the seam to the collar, and then it is easily slipped off and the other sleeve is removed. This also applies to the trousers in a compound fracture of the lower limb, or in the case of a fractured femur.

If it is a simple fracture of the leg, it is not always necessary to cut the trousers. In that case the patient is covered with a blanket, all buttons are undone, each nurse places one hand under the patient's back, and slightly raising it slips down the trousers with the other hand as far as the knees. One nurse then firmly holds the injured limb above and below the fracture, while the other nurse quickly removes the leg of the trousers, the patient being kept covered the whole time. In removing the sock, the ankle should be firmly grasped while the sock is gently removed ; or in the case of a severe injury it may be necessary to cut the sock up the side or the front.

In putting on a clean shirt, the injured side must be attended to first. In taking it off the nurse must take out the uninjured side first, to avoid any difficulty or strain on the bad side.

If a nurse has to lift or carry patients with injuries or diseased limbs, the affected side must always be the furthest away from the nurse.

Bathing and washing the patient in bed.—If a patient has to be bathed in bed, the nurse must get everything required first, so that she may not have to run away in the middle of the task. The windows near the patient should be shut, and a screen should be placed round the bed.

The nurse should get ready plenty of hot water, a bowl, soap and flannel and towels, and a clean nightshirt should be warming in front of the fire.

The top bedclothes should be removed, except the sheet. The patient's shirt should be taken off. He should then be rolled in a thin blanket, the sides folded over the front of the patient. The top sheet is then removed.

In the case of an accident it is well to wash the injured part first, so that it may be quite ready for the doctor to examine. In the case of a fracture, after the limb has been washed it should be placed between sand-bags, so that the part may be kept quite at rest while the patient is washed. Only one part should be washed at a time, and when finished should be covered up at once, so that there may be no undue exposure. When the patient has been washed all over, the clean nightshirt should

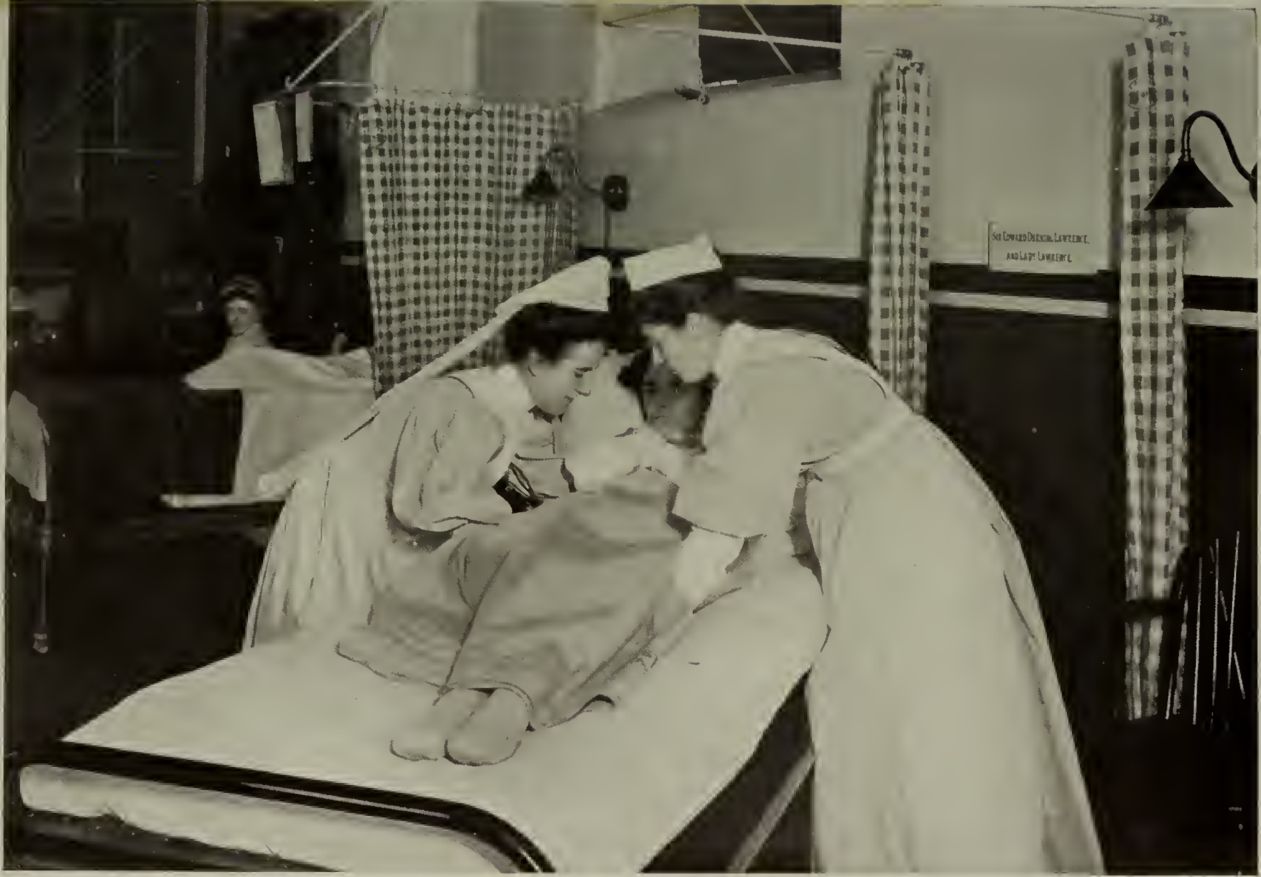
SIR EDWARD DURNING LAWRENCE, AND LADY LAWRENCE

PLATE XXVIII.—NURSES LIFTING PATIENT (LONDON HOSPITAL).

be put on, the top sheet replaced, the blanket in which the patient has been wrapped should be removed, and the bed made up in the usual way.

The bath.—If a patient is able to have a bath, the nurse must shut the bathroom window, fill the bath with water, which for an ordinary cleansing bath should be 100° F.; the temperature should always be taken with a bath thermometer. In a private house, if there is no thermometer, the nurse should test the water by placing in it her elbow and the upper part of her arm, as there the skin is more sensitive than on the hand.

A patient must never be left alone in the bathroom. Everything should therefore be prepared beforehand, so that the bathroom may not have to be left after the bath has begun. In the case of female patients in a hospital the nurse baths the patients, and a porter attends to the male patients.

It may not be inopportune here to give the temperature of various kinds of baths:—

Ice cold bath	40° to 60° F.
Cold bath	60° to 85° F.
Tepid bath	85° to 92° F.
Warm bath	92° to 100° F.
Hot bath	100° to 105° F.
Very hot bath	105° to 110° F.
Vapour bath	110° to 120° F.
Hot air bath	120° to 160° F.

In the case of very hot or very cold baths, the patient should not be plunged into a bath of the given temperature. He should first of all be put into a bath of moderate heat, and the water gradually made colder or hotter as the case may be, by adding more water.

The patient should be carefully watched during the process, and if there are any signs of collapse, the bath must immediately be stopped and the patient removed, the nurse being careful to report the matter to the Sister or the doctor.

Medicated baths of various kinds are sometimes ordered.

Coal-tar baths consist of thirty gallons of water to which eight ounces of bitumen have been added.

Alkaline baths consist of four, six, or eight ounces of sodium carbonate to thirty gallons of water.

Bran baths consist of four pounds of wheaten bran added to thirty gallons of water. After use this should be thrown away down a sufficiently large drain, as it is apt to stop up smaller ones.

Gluten baths consist of six pounds of size to thirty gallons of water. The size should be first mixed in a pail of hot water, which is then added to the rest of the water.

Sulphur baths consist of four to six ounces of sulphur to thirty gallons of water. The sulphur is dissolved in boiling water, and then added to the bath.

Cleaning teeth.—When a patient is too weak to clean his teeth himself, they should be carefully attended to by the nurse. This may be done by wrapping a piece of lint or linen round the finger, dipping it in warm water, and carefully going round the gums and teeth and roof of the mouth.

Another method is to twist a small piece of cotton wool round a pair of forceps, dip it in warm water or lemon juice and glycerine, and go round the gums and teeth in the same way. The tongue should also be gently swabbed. The patient sometimes likes to rinse his mouth afterwards with soda water or warm water.

It is particularly necessary to pay great attention to a patient's mouth when his illness is accompanied by high fever, or after an operation, or when he is being fed on milk only. The mouth should be attended to before and after each feed.

Dirty heads.—Patients are frequently brought into hospital with dirty heads. To cleanse a dirty head it should first be thoroughly washed with soft soap and hot water, to which a little lysol has been added. When dry it should be combed with a fine-tooth comb, the bed being protected by a small mackintosh cape. The nurse should have a bowl containing carbolic lotion (one in twenty) and methylated spirit in equal parts. The small comb should be frequently dipped into this. Afterwards a piece of lint or linen wrung out in carbolic lotion (one in twenty) is placed on the hair, and a piece of pink mackintosh bandaged over it. In the case of children a weaker solution of carbolic acid should be used, and care must be taken that the lint does not touch the forehead or neck. This carbolic cap should be repeated morning and evening, the hair being combed each time until it is clean.

If the head is in a very bad condition with sores and scabs, it will be necessary to get permission from the parents or the patient for the head to be shaved. The scabs must be well oiled with olive oil, and a starch poultice applied. This is made by mixing one tablespoonful of starch with cold water, and pouring *boiling* water on to it until it becomes a very stiff paste.

This is spread on a piece of linen and put on the head. Care must be taken that the poultice is *quite* cool before it is applied. It must be renewed frequently, until the scabs are quite loose. They are then removed with forceps, and the head is dressed with ointment.

The bedpan.—Bedpans should usually be warmed before giving them to a patient, by running hot water through them. They should be carefully dried afterwards. In the case of a very thin patient, or one who perspires a good deal, the rim of the bedpan should be smeared with olive oil.

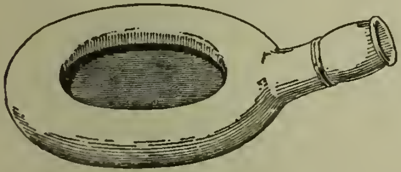
Fig. 49.—Round Bedpan.

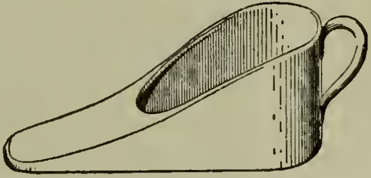
Fig. 50.—Slipper Bedpan.

If a patient can help himself a little, the bedpan can be easily given by the nurse placing one hand under his back, and with the other slipping the bedpan into position. If the patient is very helpless, two persons should always assist in giving and taking away the bedpan. It should never be dragged, as the skin is easily rubbed off and a bedsore is caused.

In some cases slipper bedpans are preferable, but in the majority of cases the round ones are more convenient, and it is best to have them made of earthenware. It is perhaps hardly necessary to mention that a lid should always be used.

Bedsores.—When a patient is kept wholly at rest in bed there is always the danger of bedsores, and these have to be guarded against from the very first.

The two chief causes of bedsores are pressure and moisture.

All prominences of bone should receive constant and regular attention.

The sacrum and the hips should be washed with soap and water at least twice a day, being carefully dried afterwards, and rubbed with methylated or some other spirit, then lightly powdered with starch or zinc powder. The shoulders, elbows, knees, ankles and heels should also be looked after.

The under mackintosh and sheet should be kept quite smooth, and the draw-sheet should be frequently drawn through, to free it from crumbs and creases. If there is any incontinence the parts should be rubbed with zinc ointment or with something of a greasy nature to resist the dampness, and each time the bed is changed the back and surrounding parts should be well washed.

If the patient is very thin and emaciated, it is a good plan to rub the back with olive oil and methylated spirits in equal parts.

To relieve pressure, if possible, a patient should be turned from side to side frequently, and a square water pillow may be placed under the back and hips.

A water pillow should be about half full, and the temperature of the water should be from 98° to 100° F. It should be placed under the draw-sheet to support the sacrum and hips, with the nozzle placed to the side of the bed. The head pillow should be drawn down to cover the top edge of the water pillow, or another small pillow inserted. Any space between a water pillow and the head pillow causes great discomfort to the patient.

Pressure may be relieved from the elbows, knees and heels by means of small circular pillows.

Should the skin crack it should be powdered with zinc powder, and white of egg or collodion painted over. Dermatol is now used for this condition with very good results.

If a bedsore occurs, it must be dressed each time the patient requires attention. Various kinds of dressing are used according to the doctor's orders. Zinc dressing, boracic, and, at some stages of the bedsores, balsam of Peru and red lotion are some of those in common use.

It must be borne in mind that the dressing must be cut the *exact* size of the wound, and that the surrounding parts must still be washed and rubbed with spirit, care being taken that the spirit does not get near the wound. The less strapping used to keep on the dressing the better, as the surrounding tissues are not in good condition, and in removing the strapping the skin may be broken.

In the case of deep sloughing bedsores, *charcoal poultices* may be ordered. These are made by mixing dry linseed meal and charcoal in equal parts before proceeding to make the poultice. The method of making will be exactly the same as in the case of a linseed poultice (*see* p. 190).

If coal-tar lotion is used instead of water for mixing the poultice, the remedy is more efficacious.

Hot-water tins.—Hot-water tins should be *quite* filled with boiling water, and the nurse should be careful that the stopper is screwed on very tightly. The tins should always be covered with thick flannel, securely tied at each end, and in placing them in the bed care should be taken to have one thickness of blanket between the patient and the hot-water tin.

The blanket should be arranged loosely over the patient's feet and legs, to allow him to move about comfortably without any danger of his coming in direct contact with the hot-water tin.

Particular care should be exercised in placing hot-water tins near a patient recovering from an anæsthetic or those suffering from paralysis or dropsy, as burns are more likely to occur in these cases.

Feeding the patient.—The feeding of a patient should be carried out regularly and punctually, and the food should be given in as inviting a form as possible.

Particular attention should be paid by the nurse to the exact amount of nourishment taken.

Feeders, tumblers, etc., should be scrupulously clean, and milk, etc., which has not been finished at one time should not be kept in the feeder and given the next time without the feeder being washed.

If a patient has to be kept lying down, but prefers a cup or glass to a feeder, it should only be half filled, or else it will spill. Sometimes a patient will take a feed more readily if he is allowed to hold the cup or glass himself. The nurse should support it too.

Milk and all fluids which may be required near at hand should be kept just outside the sick-room, the vessel being kept covered.

It is essential that a patient be made quite comfortable in bed before he begins a meal, so that he may take it easily and without undue fatigue.

In some cases it is necessary to feed a patient *through the nose*. A small-sized catheter is fixed by means of a short glass tube to some rubber tubing to which is attached a small glass funnel (Fig. 51). The catheter is lubricated with glycerine or olive oil, and passed through one nostril into the œsophagus. The fluid is then slowly poured into the funnel, and it gradually disappears.

Feeds given in this way are usually of slightly larger quantities than those given by mouth, in order that the patient need not be disturbed so frequently.

It is usual to give a nasal feed through each nostril alternately, as the nose is apt to get a little irritated and sore if this method of feeding is required for some time.

Patients may also be fed by means of an *œsophageal tube.* This method is much the same as that employed in nasal feeding, except that the tube is much larger, and it is passed through the mouth into the œsophagus.

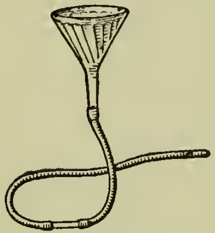

Fig. 51.—STOMACH SYPHON.

Rectal feeding is perhaps the most common way of feeding patients who are unable to take a sufficient quantity of nourishment by the mouth. This method will be described under Enemata (p. 201).

Sleep.—Sleep is a most important factor, in however slight an illness.

The nurse must notice how long a patient sleeps, and the kind of sleep, whether restless, fitful or heavy.

Much can be done by the nurse to induce sleep. She should see that the light is carefully shaded from the patient's eyes, and that the flickering light from the fire is not disturbing to him.

She should not sit and fix her eyes on the patient, and although she should be watchful, she should sit quietly away from the patient, but where he can see her and she can see him. She should be reading or working very quietly. The clicking of a needle or the scratching of a pen may be most disturbing to a patient. She should have quiet shoes and should cultivate a habit of repose. As was mentioned before, special attention should be given to the bedclothes that they are not too heavy, and it should be seen that the patient's feet are warm. Sometimes a cold wet rag laid across the eyes will induce sleep, or brushing the patient's hair, reading to him, or sponging his face and hands with either quite hot or quite cold water, will soothe him. Hot drinks may be given, or a little light food. It is a good plan after a restless night, when everything has been of no avail, to wash the patient, changing his shirt and making the bed. After this a patient will often fall asleep quite quickly.

Splints.—The different kinds of splints are described in the chapter on Surgical and Accident Nursing.

Bandages (Plates XXIX., XXX.).—Bandages are made of flannel, domette, unbleached calico, linen, muslin, or gauze.

They are cut in different widths according to the purpose for which they are required :—

Head rollers	2 inches wide.
Leg and arm rollers . . .	2½ to 3 inches wide.
Rib rollers	6 inches wide.
Finger and toe rollers . . .	¾ to 1¼ inch wide.

In preparing them the selvedges should always be removed, and the bandages should be from six to nine yards long.

In applying them the limb should be placed in as natural a position as possible; for instance, the arm should be flexed if the bandage is to be taken over the elbow.

The bandage should be begun below the place for which it is intended, and should continue for some little distance above the seat of injury.

To join a bandage, the last turn should be completely repeated. In the case of two roller bandages being required to be used at the same time as for a capeline bandage, the two ends are joined by a safety pin, or they are sewn firmly together. Small pins must never be used to fasten any bandage.

The nurse must keep in mind the object for which the bandage is required, and apply it accordingly. She should study the comfort of the patient, also the neatness and economy of the bandage.

The subject of bandaging will be treated more at length in the chapter on Surgical and Accident Nursing, but the bandages most frequently required may be briefly dealt with in this general review of the practical details of nursing.

To apply a *roller bandage* satisfactorily, the nurse should stand opposite the patient. She should have a tightly wound bandage and make a firm fixed starting point below the spot for which the bandage is required, by placing the outer surface of the bandage next the skin, and bringing it from the inner side of the limb, by the front to the outer side. She should bandage upwards and make reverses where the limb enlarges, being careful that the reverses occur on the outer aspect of the limb, and not over a wound or a prominence of bone. Figures of eight must be used over joints or where elasticity is required.

To reverse, the bandage should be held loosely in one hand, while the thumb of the other hand fixes the top border of the bandage at the highest point of the turn ; the bandage is then turned over and brought round to overlap the previous turn.

The *figure-of-eight* is made by passing the bandage alternately upwards and downwards as it envelops the limb.

A *three-cornered* or *triangular* bandage is useful in many cases, especially as a temporary bandage and as a sling.

There are three kinds of *slings*, namely, open fold, broad fold, and narrow fold.

The *open fold sling* is applied with the triangular bandage unfolded. The apex of the triangle is placed under the elbow of the injured arm, and the underneath corner placed over the opposite shoulder. The other end is taken over the shoulder on the injured side and goes round the neck, meeting the other end on the sound side, where the knot should be made. The apex of the triangle is brought round the elbow and pinned.

The *broad* and *narrow fold slings* are made by folding the triangle twice or three times, and they are applied in exactly the same way. The hand should be well supported, and in most cases should be raised a little higher than the elbow.

A *T-bandage* is made with two lengths of roller bandage. One piece is sufficiently long to tie round the waist, and to the middle of this piece is attached another length of bandage in the form of the letter T. This last piece should be long enough to reach from the waist at the back and under the perinæum, and up to the waist in front, where it is tied to the piece round the waist. It may be cut into two tails and fastened separately over each groin.

A *many-tailed bandage* is made with a piece of material sufficiently long to tie round the limb and wide enough to cover the injury well. The piece of stuff is then cut into strips, each side, of about an inch or one and a half inches wide, leaving a piece of material in the middle sufficient just to envelop the limb.

This bandage may also be made by joining the requisite number of strips, slightly overlapping each other on to a central piece of bandage.

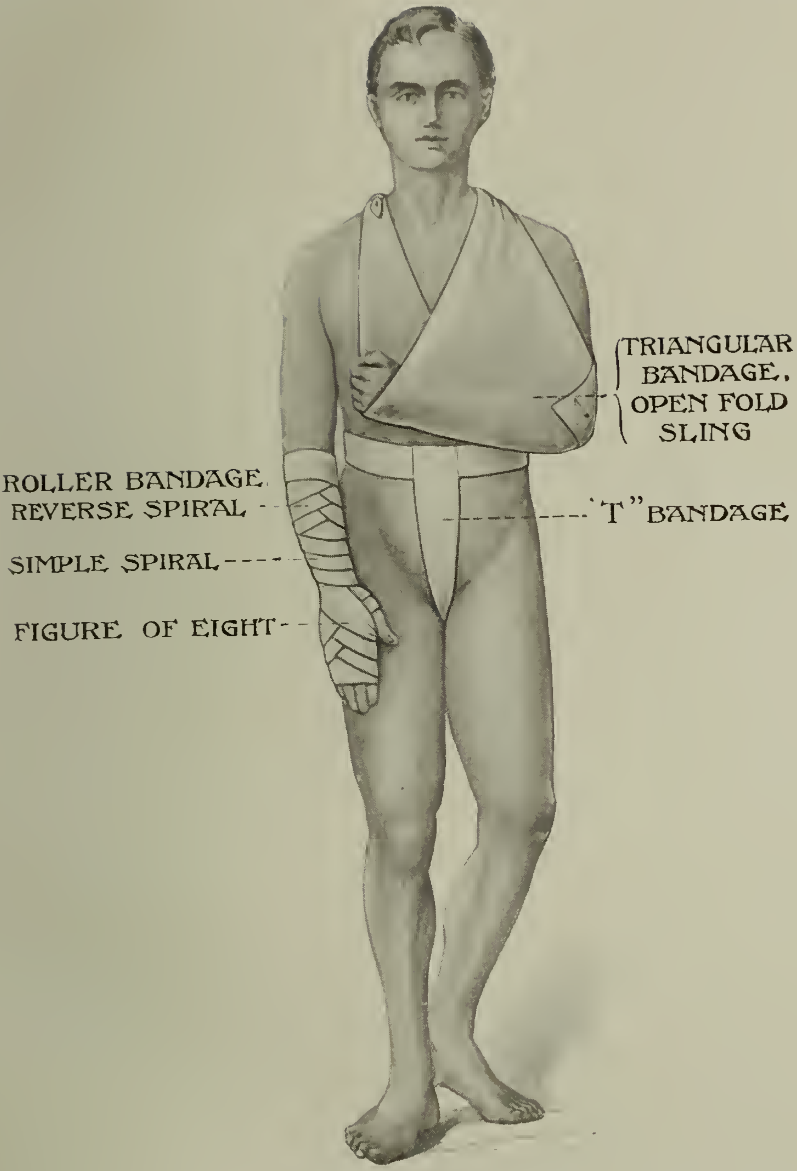

PLATE XXIX.—BANDAGES.

This form of bandage is most useful when fomentations have to be applied, as it enables them to be changed very frequently without moving the limb.

Abdominal binders are made of flannel, from ten to fourteen inches wide, the length being adapted to the size of the patient. The portion of the binder which goes under the back is lined with lint, which must be neatly sewn on, care being taken that the edges are flat and smooth, and that the lint is a trifle wider than the flannel.

Stirrups are sometimes useful to keep a binder in place. They are pieces of bandage fastened to the back of the binder and brought round under each thigh, and fastened to the binder in front with safety pins.

Bandages should be tied in a "reef" knot. This is made by passing the right end over the left, and then left over right. This knot does not slip, it is easily untied, and is neat, as the ends lie parallel with the bandage, and can be tidily tucked in.

Strapping is used to supply support to various parts of the body. Before being applied it should be cut into the required length and width. Strapping is warmed before application by holding the non-adhesive side round a tin filled with hot water.

The strapping for fractured ribs should be cut about three inches wide, and long enough to reach from the backbone to the sternum.

The strapping should commence at the highest point of the part it is intended to cover, and should start from the back, being brought firmly round to the front.

It is applied downwards, and each strip should overlap the previous one by about one half. The whole should be covered by a firmly applied rib bandage.

Before putting on strapping to enable an extension to be applied to a leg, the limb should be well washed to remove any grease, as this prevents the strapping from holding properly. The long pieces of strapping to which the extension is applied are placed smoothly on each side of the leg. These are kept in place by putting short pieces of strapping round the leg. It is a good plan to cut small holes in the loose pieces going over the ankle bone, to prevent any friction. A domette bandage should be applied to the leg over the strapping.

Ulcerated legs are sometimes treated with strapping.

The nurse should stand in front of her patient and should have the strapping cut in strips of about one to one and a half inches in width, and sufficiently long to pass round the leg and cross in front.

The middle of each piece of strapping should be placed at the back of the leg, brought round to the front and the ends crossed over. It should be applied upwards, beginning well below the ulcer. Each piece of strapping should overlap the previous piece by one third. As a rule the ulcer is left exposed, so that the dressing ordered can be changed as frequently as necessary.

To remove strapping from a wound, it should be loosened from each end towards the wound. Great care must be taken to prevent any breaking down of or injury to the union that may have taken place. In removing strapping, if the nurse firmly presses the patient's skin with the other hand beneath the strapping she is taking off it will considerably lessen the discomfort.

To get off the dirty marks left by strapping a little oil should be used. Turpentine and chloroform can be employed for this purpose too, but they may blister a patient's skin, which is usually rather sensitive where the strapping has been.

Application of cold.—Cold and heat act by modifying the supply of blood to the surface, this being diminished by cold and increased by heat.

Cold is applied in a variety of ways: as a liquid, as in cold baths, cooling lotions, etc., and as a solid, in the form of ice bags and Leiter's tubes.

A cold bath is given from 60° to 80° F., and an ice-cold bath at a lower temperature than that (*see* p. 175).

Great care should be taken in giving these cold baths. The patient should be carefully watched, and should not be kept in the bath more than from three to five minutes if no special orders have been given.

In the case of an ice-cold bath restoratives should be at hand. The patient should be wrapped in a sheet and gently lowered into the bath, one arm being left uncovered that the pulse may be easily felt.

The bed should be quickly made, with a mackintosh and blanket placed over the under sheet, to receive the patient when he is lifted back from the bath. Hot bottles and hot blankets should also be ready.

Sponging.—Cold sponging is sometimes ordered. The nurse should see that the windows near the patient are shut. A screen is placed round the bed, and the top bedclothes except the sheet or blanket next the

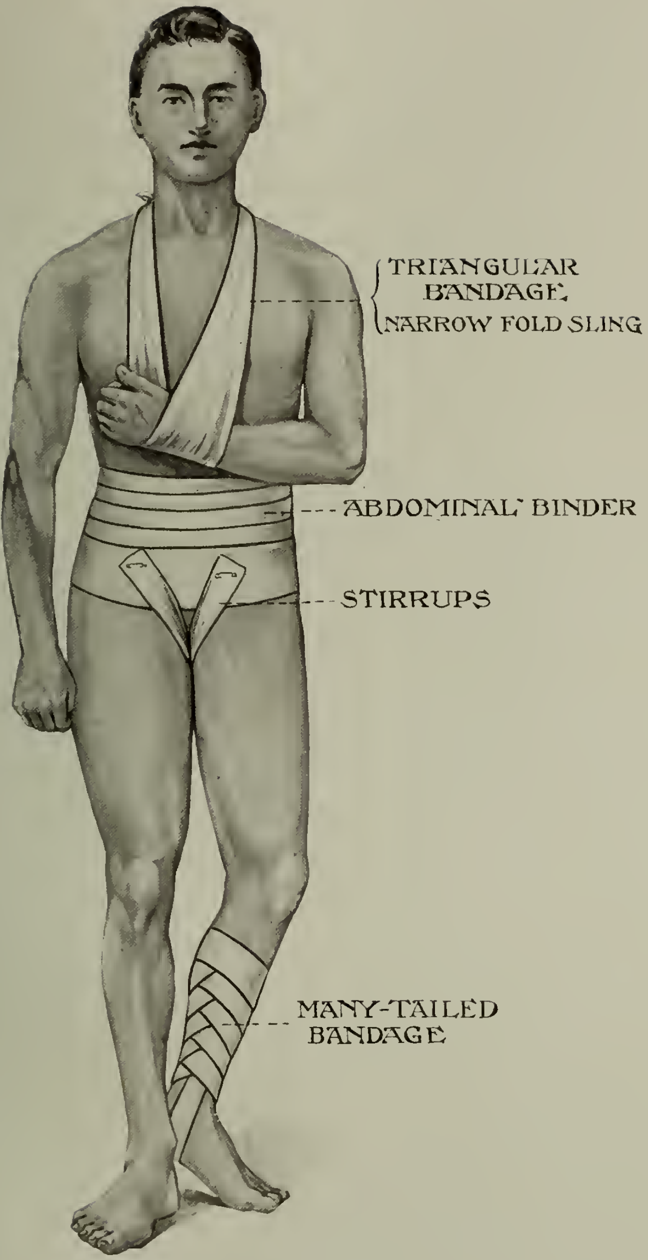

PLATE XXX.—BANDAGES.

patient are removed. The patient's nightshirt is taken off and placed by the fire to air. He is then rolled into a thin blanket, and the remaining sheet or blanket over him is removed.

The nurse then sponges each limb, taking long sweeping strokes downwards, care being taken to dip the sponge frequently into the water, and not to wring it out too dry. Parts that must have special attention are those between the fingers and toes and behind the ears, the axillæ, and the groins. The abdomen is sponged without exposing the patient at all, the nurse just raising the blanket and passing the sponge down the body. The whole process should take from ten to fifteen minutes. The patient is then wrapped in the blanket and left for about twenty minutes. After this his temperature is taken, the nightshirt is replaced, and the bed made up again in the ordinary way.

Tepid or hot sponging is done in exactly the same way, except that a little longer time should be taken over it. In any kind of sponging there should be no bustling. It ought to have a soothing effect.

Cold pack.—To give a cold pack, the top bedclothes should be removed except the sheet. A mackintosh and blanket should be placed under the patient, and then his shirt removed. A sheet should be wrung out of cold water and placed under the patient, and another wet sheet over him. The under blanket should then be folded over him and another blanket over the top. The pack should last from thirty to fifty minutes.

Ice bags.—These are frequently ordered when cold has to be applied locally.

The ice bag should be about half full of fairly large pieces of ice, and should be suspended so that the whole weight of the bag does not rest on the patient. Between the ice bag and the skin a single fold of lint should be placed to absorb the moisture condensed on the surface of the ice bag, and to prevent frost-bite. Directly all the ice is melted, the bag should be emptied of water and fresh ice put in.

Small ice bags for the throat, eyes, nose, etc., can be made by the nurse with gutta-percha tissue cut the size and shape required. The ice must be crushed and placed between the tissue, the edges being stuck together with chloroform. When the ice has to be renewed, the extreme edge of the tissue bag is cut off, fresh ice is put in and the edges sealed again with chloroform.

Ice is best kept in a large lump, and should not be broken up until wanted. If there is no refrigerator it should be wrapped in flannel and placed on another piece of flannel tied tightly over a small bath or vessel of some kind. The ice should be surrounded with salt and kept in the dark.

Ice is most easily broken with something with a very sharp point. A hat pin or darning needle will serve the purpose quite well. It can be broken quite quietly if the nurse holds a lump on a small cloth in her hand and uses a needle for dividing small pieces.

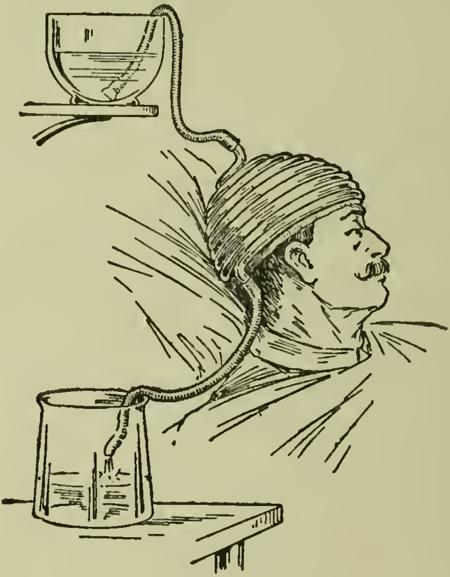

Fig. 52.—Leiter's Tubes.

If a patient has ice to suck, it can be kept near the patient in convenient cups with strainers made for this purpose. One can be improvised by tying a piece of flannel over an ordinary cup or tumbler and placing the ice on that.

Leiter's tubes.—These are used when a steady supply of cold is required to any part of the body. They are most commonly used round the throat and on the head, but they can be applied to almost any part.

They consist of a coil of small metal tubes, which are fastened round the part to be treated, a piece of lint being placed between them and the patient. There is a rubber tube fixed at each end of the tubes. The top rubber tube is placed in a vessel containing cold or iced water fixed high above the patient. The rubber tube fixed to the lower end of the metal tubes is placed in an empty vessel, into which the water runs after it has circulated through the metal tubes.

Application of heat.—Heat may be applied either dry or moist. A patient can bear dry heat of a greater temperature than moist.

The effect of dry heat, applied *generally*, is to induce perspiration. When it is applied *locally*, it is to supply heat to the part with which it is placed in contact.

Moist heat is prescribed for its sedative effect, or as a slight counter-irritant.

Hot-air baths are frequently ordered for some forms of kidney disease.

The windows near the patient should be closed before a hot-air bath is given. The top bedclothes are removed, and also the patient's shirt, which is placed by the fire. The patient is rolled into a warm blanket and a warm mackintosh is placed under him.

One long or two shorter cradles are placed over him, and the pipe of the apparatus should come between the legs, each of which should be well wrapped up separately in the blanket in which he is rolled.

Mackintoshes are placed over the cradles and a blanket over the top, the edges being well tucked in underneath the bottom mackintosh and under the patient's chin. A bath thermometer should be placed over the blanket covering the patient, towards the head of the bed, so that it can be reached easily during the bath to watch the temperature.

The lamp belonging to the apparatus is now lighted, and there should be a good flame.

The usual temperature of a hot-air bath is from 120° to 140° F.

If pilocarpine is ordered, the injection should be given hypodermically, just as the patient is put in the bath. This drug causes great salivation, and a nurse should be at hand to keep the patient's head on one side to facilitate the escape of the saliva, and frequently to wipe his mouth. A cold wet rag on the forehead is often a relief to the patient, and he should be given hot or cold drinks while he is in the bath.

When the bath has reached the required temperature, the lamp is put out, the apparatus is removed, and the cradles and mackintoshes are drawn quickly from underneath the blankets. The patient is then left as he is, to cool down. In about twenty minutes he is quickly sponged down with hot water. A warm nightshirt should be put on and the bed made up with warm dry blankets.

Hot packs are sometimes employed in cases of dropsy, uræmia, etc.

The top bedclothes should be removed except the blanket covering the patient. A mackintosh should be placed over the bottom sheet covered with a warm blanket. The patient's body linen should be removed and put near the fire.

If the bathroom is not conveniently near, a large foot or hip bath should be placed by the bed with water 10° hotter than the required heat of the pack. The usual temperature at which a pack is given is 105° F.

A thin blanket or sheet is wrung out in the bath. It usually takes two persons to do this. The blanket or sheet is folded lengthwise, the ends are held and the rest of the blanket or sheet dipped into the water. The ends are turned in opposite directions, and the blanket or sheet is wrung out very dry. The patient is then quickly rolled into it, covered with a warm mackintosh, and the under blanket and mackintosh folded over him. Another blanket is placed over the top and tucked in round the patient.

The quilt can be replaced, and the bed will look quite neat.

A patient usually remains in a hot pack for about an hour, but he may remain longer if comfortable. A hot pack often has the effect of inducing sleep.

In taking a patient out of a hot pack, it is best to remove the mackintoshes and damp blanket, and to leave the patient rolled in a warm dry blanket for a short time.

He is then washed quickly all over with hot water, his warm shirt is replaced, and the bed is made up in the usual way. Great care must be taken to protect the patient from draughts during the process, and while a patient is being put in or taken out of a hot pack the windows should be shut.

When *mustard baths* are ordered, the mustard should be tied up in a muslin bag. The usual quantity is one tablespoonful of mustard to a gallon of water.

Dry heat is applied locally in the form of hot bottles or bricks, or flannel bags filled with hot salt, bran or hops.

Moist heat is applied locally in the form of fomentations and poultices.

Fomentations.—Pieces of flannel or of soft old blanket cut the required size are the best materials to use for fomentations.

A wringer, made like a small roller towel, is placed over a bowl. Two short sticks should be placed one in either end of the wringer, the flannel placed on the top of it, and the boiling water poured well over the flannel. It must then be wrung out quickly by turning the sticks in opposite directions.

When as dry as possible untwist and slip out the sticks. Give the flannel a good shake and place it lightly on the patient. Cover the fomentation with a piece of mackintosh cut a size larger than the fomentation and with a piece of wool.

A piece of spongio-piline is better. This is a thick material with mackintosh one side. The edges should be bevelled inwards, so that the mackintosh completely covers the whole.

Between the changing of the fomentations the wringer should be dried. In changing a fomentation another flannel should be wrung out ready to replace the other, so that the patient is not kept long uncovered.

Turpentine fomentations or *stupes* are made exactly like a simple fomentation, except that *before* pouring on the boiling water the flannel is sprinkled evenly with the turpentine. The quantity of turpentine used is usually one drachm. The boiling water should well saturate the flannel, which should then be wrung out. The skin of children and old people is particularly susceptible to turpentine, and as it is a powerful irritant it should always be used with care.

If turpentine stupes are to be continued, it is a good plan to smear the skin with a little olive oil each time the stupe is renewed.

In making an *opium fomentation* the flannel should be wrung out *first* and then sprinkled with the quantity of opium ordered. The usual amount is ♏xxx.

Sometimes *poppy-head fomentations* are ordered. Four ounces of dried poppy heads are taken, and the seeds are emptied out. The shells are then boiled in three pints of water for a quarter of an hour. The decoction is then strained and is ready for use. The flannel is wrung out of the decoction and applied in the usual way.

Camomile-flower water is made in the same way.

Belladonna fomentations.—Paint the part affected with a thick coating of belladonna and glycerine, and then apply over it a fomentation, consisting of a piece of white lint or flannel wrung out of boiling water. Cover with a piece of pink mackintosh and a layer of cotton wool and bandage it on.

Poultices.—Before beginning to make a *linseed meal poultice* the nurse should get to hand all she will require.

In hospital a poultice is generally spread on a tow mat, which is prepared first by teasing out tow in a thin layer and crossing and re-crossing it with other layers. A convenient method in a private house is to spread the poultice on a piece of old linen.

There should be a kettle of boiling water, a poultice bowl, a basin or jug, a poultice spatula or large knife, a poultice board, a little olive oil, and the linseed meal.

Two large plates should be put near the fire to get warm.

Some boiling water should be poured into the poultice bowl to make that thoroughly warm, the spatula being dipped into it. This water is then poured into the basin or jug, and the spatula placed in it.

Sufficient boiling water is next poured into the poultice bowl for the sized poultice required. The linseed meal is sprinkled into it quickly with the left hand while the nurse stirs it with the spatula in her right hand in one direction all the time. The poultice should be made of the consistency of porridge, and should be just thick enough to leave the sides of the bowl clean.

It should then be turned out on to the tow mat or linen and spread quickly and evenly, the spatula being frequently dipped into the basin or jug of hot water. The poultice should be about half-an-inch thick all over. The edges of the tow or linen should be neatly folded in. A little olive oil should be spread over the poultice, which is then rolled up. It is placed between the two hot plates and taken to the patient. Poultices should be put on as warm as the patient can bear them, but care must be taken that they are not too hot.

Over the poultice should be placed a piece of jaconet and cotton wool or gamgee tissue.

If the poultice is for the side or the abdomen, a flannel abdominal binder (Plate XXX.) is the best way of keeping it in place.

If it is ordered for the upper part of the chest, the use of a triangular bandage is a comfortable and easy method of keeping it in position.

In changing a poultice the fresh one should always be ready before the other is removed. When the poultice is discontinued, the skin should be gently washed with warm water and well dried, and a warm piece of gamgee tissue or cotton wool should be applied to the part where it has been.

Large poultices should be changed every four hours at least, and small poultices every two hours, and sometimes more frequently.

Bread poultice is made by preparing a sufficient quantity of bread crumbs. They are stirred rapidly into boiling water in the same way as a linseed poultice is made. The mixture is then well beaten, covered with a saucer, and the vessel is placed over a saucepan of hot water to make the bread swell.

Any water must be thoroughly drained off, and the poultice is then spread evenly with a heated knife on a piece of linen the required size, the edges of which are turned neatly in. Olive oil, or some simple ointment, such as cold cream, is spread on the poultice to prevent it from sticking, and it is applied, being covered with wool and bandaged on.

Bread poultices may be ordered to be applied hot or cold. If the former they must be changed very frequently, as they do not retain the heat for any length of time.

Bran poultice.—Place the bran in a flannel bag and saturate it with boiling water. It can be squeezed sufficiently dry for application between two boards, or with a rolling-pin on a poultice board.

Starch poultice (*see* p. 177).

Charcoal poultice (*see* p. 178).

In making *mustard and linseed poultices* it is a good plan to mix the mustard with a little cold water first and then to add the boiling water required for the poultice, and the method is the same as in making a linseed meal poultice.

Mustard plasters.—Mustard leaves procured from the chemist are usually preferred now to mustard plasters, but they are a great deal more painful.

To make a *mustard plaster* the mustard should be mixed, with *cold* water, to a fairly thick consistency. There should be prepared several layers of tissue paper the size of the poultice required, on the top of which the mustard is evenly and thinly spread. A single layer of tissue paper is placed over the top, and the edges are neatly folded over. This is preferable to muslin, as the particles of mustard are less likely to get through to irritate the skin.

The plaster is kept in place on the patient by means of pieces of strapping, with cotton wool over it.

Mustard plasters should not be kept on long enough to raise a blister or to break the skin. Particular care is required in the case of old people and children. When the plaster is removed a little olive oil should be smeared over the reddened surface, or some simple ointment dressing, such as zinc or boracic, may be applied with a layer of cotton wool over it.

Counter-irritation.—Cupping, blisters and leeches are some of the methods used to produce counter-irritation, the object of which is to counteract a deeper-seated inflammation.

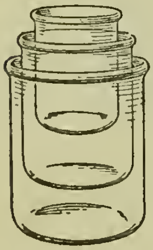

Fig. 53.—Cupping Glasses.

Wet cupping is seldom or never used now.

For *dry cupping* glasses of various sizes are made. The usual site for dry cupping is the loins, just over the kidneys, and it is used as a rule in cases of inflammation of these organs.

The edges of the cupping glasses should be lightly smeared with olive oil.

Having placed the patient in a convenient position with the part exposed which is to be cupped, a small spirit lamp lighted is taken to the bed with the cupping glasses.

A glass is held over the flame for a few seconds and placed quickly and firmly on the spot. Two or three other glasses are applied in the same way. Then take the first one off by pressing down the skin near the rim of the glass, and inserting the nail of the thumb under the edge. The glass is heated again, and the same process is gone through, and so with the other glasses until the skin is well reddened. To keep up the counter-irritation a little longer a fomentation may be applied over the region that has been cupped.

Blisters may be applied in the form of a plaster or with blistering fluid. Before a blister is applied the part should be washed with soap and water, and rubbed over with ether to remove any grease.

If a plaster is used it should not be bound down tightly to the skin with sticking-plaster, as this makes it very painful for the patient when the blister begins to rise.

Before painting with blistering fluid, it is well to define the surface the blister is intended to cover with a slight outline of olive oil or vaseline. This prevents the blistering fluid from spreading or running where it is not required. When the fluid has dried into the skin a small piece of lint should be put over it and kept in place by two pieces of strapping laid lightly over it, plenty of room being allowed for the blister to rise.

A blister takes from six to twelve hours to rise. If it is very slow in rising, a fomentation placed over it will help to hasten it.

If a blister has to be applied to a joint it is better to apply it just above and below the joint rather than exactly on it.

To dress a blister, a small saucer or a piece of cotton wool should be held under the blister. It is then snipped with sterilised scissors at the most dependent part. The blister is very gently pressed, but the cuticle is not removed.

It is then dressed with a simple ointment dressing, such as zinc or boracic, which should be renewed twice or oftener if necessary during the twenty-four hours.

If it is desired to keep the blister "open," the raised cuticle is removed with a pair of scissors, and the place dressed with the irritant application ordered. The dressing should be the exact size of the sore.

Leeches are still sometimes used for taking away a small quantity of blood. They should not be applied over a large blood vessel.

The part to which they have to be applied must be well washed with soap and water. If several leeches have to be applied to a small area, they can be put in a wineglass, and the glass turned on to the spot. If the leeches will not bite, the part should be moistened with a little milk or sugar and water, or the leeches may be plunged into cold water, or again a fomentation may be applied for a short time to the area to which the leeches are to be applied.

If a leech has to be applied close to the eye or behind the ear it is best to half-fill a test tube with cotton wool, and then put the leech in, being careful that its head is at the mouth of the tube, and place the tube over the exact spot where the leech is required.

Leeches must be left undisturbed when they have fastened on. They will drop off when they have finished. If for any reason the nurse wishes to remove the leeches before they drop off, she should not pull them away, as their teeth will be left in the wound. A little salt sprinkled on them will cause them readily to fall off.

If they are required again they should be placed in salt and water, when they will vomit the blood they have taken. They are then placed in clean cold water. If they are not required for future use, they should be placed in carbolic acid lotion (1 in 20), which quickly kills them.

A pad of wool should be placed over the leech bites. If the bleeding does not soon stop, a tiny piece of wool teased out should be put over each bite, and a pad of wool on the top, and a little pressure applied. If the bleeding is still persistent a small piece of ice may be applied to each bite, or a little dry linseed meal may be sprinkled on the surface. If these remedies are not effectual, the doctor may apply a little tincture of iron or some other styptic.

Surgical dressings.—Surgical dressings are composed of gauze which is either plain white gauze or gauze prepared with some chemical. The gauzes are usually distinguished from each other by some colour; for instance, sal-alembroth dressings are treated with a preparation of mercury, and are coloured blue, cyanide dressings are treated with cyanide of mercury, and are coloured a pale heliotrope, etc.

Lint also is used for surgical dressings, and when it is treated with boracic it is coloured pink.

After dressings have been cut the required size and shape they are usually sterilised before being used.

This is done by placing them in a tin box specially made for the purpose, or by putting them in a brown holland bag lined with cotton wool, and placing the box or bag in an oven heated to 270° F. The dressings are baked in this temperature for an hour. The boxes are then sealed down and are not opened until required for use. Towels and the white coats worn by the surgeon are also sterilised in the same way.

Nurses must remember most thoroughly to cleanse their hands, nails, and arms to the elbow, not only before and after doing a dressing, but also before handling dressings.

In preparing dressings these should be taken from their wrappers and placed on a clean mackintosh spread on a table. If a nurse is interrupted while preparing dressings she must cover them carefully with the mackintosh and re-prepare her hands before beginning again.

In doing dressings herself or preparing them for the surgeon, the nurse should always see that everything is quite ready before the dressing is begun, and that the windows in the vicinity of the patient are shut.

A nurse should never touch wounds or soiled dressings with her fingers, but with a pair of sterilised forceps.

Dressings must never be removed roughly when sticking to the wound. They must be saturated with warm water to which some antiseptic has been added, and gently removed, not only to avoid hurting the patient, but to prevent breaking down any union that may have taken place in the wound.

In washing wounds, warm sterilised water is now generally used (some surgeons, however, still prefer warm water to which some antiseptic has been added), applied with small pieces of cotton wool enclosed in gauze. Pads of gauze only are also much used for this purpose.

Marine sponges are seldom if ever used in *dressing wounds.* They are still used by surgeons in some abdominal and throat and tongue operations, and when this is the case they must be very carefully prepared.

A nurse must avoid touching the edges of a wound when washing it, and the gauze swab which is soiled with discharge should not be redipped into the lotion.

A wound must never be left uncovered. If a fomentation has to be applied, the wound should be covered with a swab wrung out of the antiseptic lotion while the fomentation is being prepared.

In *dressing burns,* the dressing, which usually consists of some simple ointment spread on lint, should be cut into strips about half a yard long and a few inches wide. Then as one piece of dressing is removed another piece is put on, and the whole burnt surface is not exposed at the same time. A burnt patient suffers much from shock, and it is sometimes necessary to give him some stimulant in the middle of doing the dressing, or perhaps to do one limb at a time, allowing an interval between. Troublesome contractions are apt to occur after severe burns, and the nurse should not lose sight of this tendency.

In *spreading ointments* it is usual to use the smooth side of the lint. In the winter, or if the ointment is very hard, like Scott's dressing, it facilitates the spreading if the spatula is frequently dipped into hot water.

Ointments should be spread as evenly as possible, and not too thickly.

In *applying fomentations* to a wound, a double fold of boracic lint is placed in a wringer, boiling water is poured over it, it is wrung out, taken from the wringer and shaken and placed on the wound, being covered with a piece of jaconet (pink mackintosh) a size larger than the lint, covered with a pad of cotton wool, and bandaged to keep in place.

A *lysol* fomentation is made by adding one drachm of lysol to a pint of boiling water. This is poured over a double fold of white lint, cut the required size, wrung out and applied in the way described on page 195.

Evaporating lead lotion is applied to an inflamed limb by soaking a single fold of white lint in the lotion. It is wrung out and placed on the limb, leaving it exposed to the air. The bed should be protected by placing a small piece of oiled cotton under the limb. By the side of the patient should be a covered bowl containing the evaporating lotion in which another piece of lint is soaking. When the lint on the limb becomes hot, it should be replaced by the piece which has been kept in the lotion.

Care of surgical instruments.—After an operation or a dressing has been completed, the *instruments* should be returned to a bowl of lotion, and the blood and pus washed off with a swab.

The instruments should then be thoroughly washed with hot soap and water, the teeth and hinges being scrubbed most carefully with a nail brush kept for the purpose.

The instruments should next be boiled for five minutes in soda water—that is, water to which soda has been added in the proportion of one drachm to the pint of water.

This soda solution should be quite boiling before the instruments are put in. After being boiled for five minutes they should be placed in a tray containing sufficient methylated spirit to cover them. They are then dried with a sterilised towel and kept in an instrument cupboard composed of glass and enamelled iron, or in a metal box, which can be boiled.

Any instruments which are to be used in a dressing should be boiled immediately beforehand in soda water for five minutes, and then placed in a bowl of carbolic lotion and taken to the patient's bedside, to be used as required.

Knives, scissors, and needles are not usually boiled, as it blunts their edges. They are washed in the same way as the rest of the instruments, and are then placed in absolute alcohol or some strong antiseptic for half an hour. If they must be boiled it must be for only one minute in the soda solution.

The antiseptic lotions in general use* are carbolic acid, perchloride of mercury, biniodide of mercury, boracic acid, lysol, sanitas, Condy's fluid or permanganate of potash, and iodine.

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* *See* also *ante*, pp. 72-75.

Carbolic acid is a strong poison with a distinct taste and smell. It is very volatile, and is thus useful as a deodoriser. It is used in the strength of 1 in 20 for instruments and disinfection, 1 in 40 for washing wounds, etc., 1 in 60 for the hands, 1 in 80 to 1 in 100 for gargles and mouth wash.

Perchloride of mercury (corrosive sublimate) is a colourless fluid with no taste or smell. It is a deadly poison, and is used in very weak solutions. It is therefore cheap for general use in a hospital. One part perchloride of mercury to 1,000 parts of water corresponds to 1 in 20 carbolic acid solution. Perchloride of mercury must never be used for instruments, as it corrodes them, and it discolours sponges.

Lysol is a brown sticky fluid. It is an effectual germicide, and the strength usually employed is one drachm of lysol to one pint of water. It is used for fomentations and for disinfecting the hands.

Biniodide of mercury is used generally in preparing the skin before an operation, in the strength of 1 in 500 spirit solution. After the skin has been well rubbed with this solution, care should be taken that it is thoroughly washed, as if biniodide is left on for any length of time, it will cause a burn-rash. A watery solution of biniodide of mercury, 1 in 1,000, or 1 in 2,000, is used for disinfecting the hands.

Boric acid is a colourless, tasteless fluid, which is employed for fomentations and for bathing sensitive organs such as the eye. It is generally used in a saturated solution ; one ounce of boric powder is absorbed by one pint of water. Injections of boric acid are sometimes given to soothe the mucous membrane of the rectum.

Sanitas is a deodoriser, and is sometimes used as a mouth wash in the proportion of one tablespoonful to a pint of water.

Condy's fluid is a dark red fluid, which rapidly turns brown on exposure to the air. It is usually employed for vaginal douches in the proportion of one drachm to one pint of water.

Iodine is a brown fluid, mostly used for uterine douches, in the strength of one drachm to one pint of water.

Taking the temperature.—In order to ascertain the temperature of a patient a clinical thermometer must be used.

The normal temperature of the body is 98.4°, but this may vary in health from 97° to 99.6°, and in disease from 96° to 106°, or even higher.

The temperature may be taken in the axilla, in the mouth, the groin, or the rectum. It should not be taken in the mouth of delirious patients or of children, as they might bite off the bulb of mercury.

When the temperature is taken in the mouth or rectum it is a degree higher than when taken in the axilla, so that it should be taken in the same place each time, otherwise the variation will be misleading.

Before inserting the thermometer the mercury should be shaken down to below 95°.

To get a correct temperature in the axilla, the part should be quite dry. The bulb is placed in the axilla, care being taken that no clothes come between it and the skin. To enable the thermometer to be held firmly in position the patient's arm should be brought across his chest, his hand pointing to the opposite shoulder. After five minutes the thermometer should be withdrawn, and the temperature carefully recorded on the chart provided for the purpose.

The chart on which temperatures are recorded is marked out to represent the same degrees as the clinical thermometer.

When the thermometer is taken away from the patient the point to which the mercury has risen must be shown by a dot of ink on the corresponding spot on the chart. Next time the temperature is marked on the chart the dot is connected with a line to the former dot, and thus it is easy to see at a glance the variations which have taken place (Plate XXXI.).

No patient should be allowed to insert or withdraw the thermometer, for in that case the nurse could not be certain that it was placed rightly, or that it had not slipped.

The bulb of the thermometer should be oiled before it is inserted in the rectum.

When the temperature is taken in the mouth, the bulb should be placed under the tongue and the lips closed.

After use the nurse should wash, and if necessary disinfect, the thermometer.

For further details of temperature-taking, *see* pp. 162-63.

The pulse.—In order to ascertain the pulse, two fingers should be placed on the radial artery, slightly compressing it.

This artery will be found at the wrist, practically in a line taken downwards from the tip of the thumb.

The beats are counted for one minute. The normal pulse is 72 beats

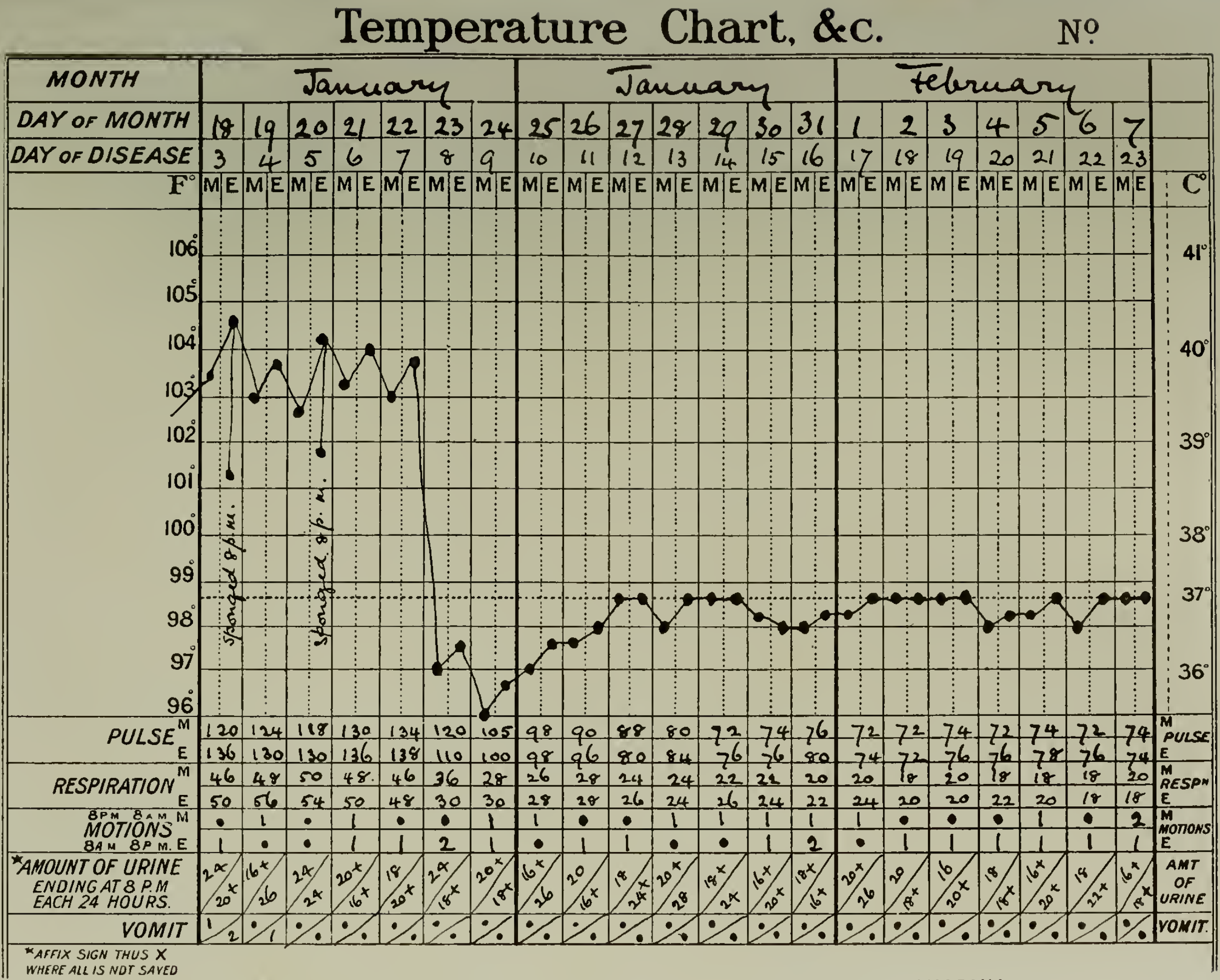

PLATE XXXI.—TEMPERATURE CHART IN A CASE OF PNEUMONIA.

per minute, but it varies in health from 60 to 80, and in disease from 30 to 200 (*see* p. 164).

Respiration.—The normal respiration is from fifteen to twenty inspirations and expirations a minute. It varies in disease from twelve to sixty. In Cheyne-Stokes breathing (p. 149) the respiration may be as low as four per minute. It is ascertained by the nurse taking the patient's arm across his chest, and placing her fingers on the wrist as though she were taking his pulse. She then feels the chest rising and falling, these two movements counting as one. She counts for one minute.

If the patient knows his respiration is being taken, he will involuntarily breathe more quickly than usual.

If a patient is asleep, the nurse can watch and count the movements of the chest.

Enemata.—Enemata are injections into the rectum, and can be divided into two classes, namely, those to be returned, and those to be retained.

Speaking generally, those to be returned are given with a Higginson's syringe at a temperature of 100° F., and those to be retained with a catheter and funnel at 98° to 99° F.

In the giving of an enema the patient should lie on his left side, with his knees drawn up and the buttocks near the edge of the bed. In some cases if a patient cannot be turned on his side, his right leg should be drawn up, and the nurse should pass her hand underneath it, when she will readily introduce the nozzle of the syringe into the rectum. Very occasionally the "knee and elbow" position is found best. Then the patient kneels in the bed with his elbows pressed into the pillow.

Before inserting the nozzle of a Higginson's syringe into the rectum, the nozzle should be well oiled and all air expelled. The latter object is accomplished by placing the metal end of the syringe in the solution to be given, and working the ball in the middle of the syringe until there is a steady flow of the fluid through the nozzle. The nurse must be careful to see that the metal end remains covered by the solution.

Before giving an enema, the nurse should have at hand some utensil and cover in readiness for the result, also a towel. After withdrawing the nozzle the buttocks should be pressed together for a few minutes, as this helps the patient to retain the injection a little longer.

When an irritant such as turpentine is used, the nurse must be careful that none of it gets on to the surrounding parts. The patient should be carefully washed afterwards, and care must be taken that no turpentine is allowed to be on the nozzle of the syringe.

When an enema has to be retained, the catheter should be inserted about six inches after being well oiled. To the end of the catheter should be attached, by a short glass tube, a piece of tubing on which a glass funnel is fixed.

There is more chance of a patient's retaining the injection if the buttocks are raised on a pillow, and the foot of the bed may also be raised. The injection should be fairly cool, as it is less likely to irritate the bowel, and it should be given slowly. This is done by holding the funnel low down, almost on a level with the anus. After the catheter is removed the buttocks should be pressed together with a towel for several minutes, and the patient encouraged to lie still.

Before giving an injection which is to be retained, the nurse should ascertain that the bowel is perfectly free. If it is not clear a simple soap and water enema should be given an hour before the other injection is administered.

The following are the enemata in common use :—

A *simple enema* consists of one and a half to two ounces of soft soap to one pint of water. This is given with a Higginson's syringe at a temperature of 100° F. The soap is warmed by being placed by the fire, and is then rubbed down with a little warm water into a creamy substance, and the rest of the water is added. It is given as a purgative.

Ordinary yellow soap may be used. It is best to shred it quite finely, pour over it a little boiling water, and let it stand in a warm place to melt. If there are many lumps it is best to strain the enema before giving it.

For a *turpentine enema*, which is given to relieve flatulence, ℥i of turpentine is required to Oi or Oii of soap and water. The turpentine is mixed with ℥viii of the soap and water and given first, followed by the remainder of the soap and water without withdrawing the nozzle.

Castor oil (℥i to ℥ii) is given in the same way. *Valerian* (ʒii to ℥ss.), too, can be conveyed by this method.

A *magnesium sulphate enema* consists of pulv. mag. sulph. (℥ii) with sufficient warm water to dissolve it. It is given with a catheter and funnel.

Olive oil (from ℥iv to ℥x) is given warm with a catheter and funnel, and it is followed in half an hour with a simple soap and water enema. The oil is warmed by placing the vessel containing it in a basin of hot water.

Glycerine is given warm with a special syringe holding ʒii to ℥i. This is a mild laxative, and is usually only given to children.

Salt and water, given warm with a Higginson's syringe, consists of ℥i of salt to Oi of water. It is given to children suffering with thread worms, and is best injected directly after an evacuation of the bowels.

Starch and opium is given to check diarrhœa. It should be injected slowly through a catheter and funnel, and should be nearly, if not quite, cold. It consists of mucilage of starch ℥iii to tincture of opium ♏xxx for an adult.

Sometimes orders are given that the starch is to be made with cold water, but as a rule thin starch made with boiling water is more effectual. It should be allowed to cool thoroughly, and it should be measured before adding the opium.

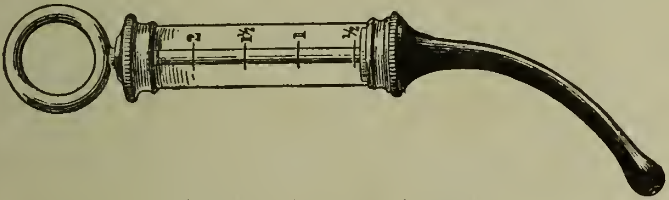

Fig. 54.—Glycerine Syringe.

An injection of *coffee and brandy* is frequently ordered as a stimulant, and is composed of strong strained coffee ℥iv to brandy ℥ii. It is given with a catheter and funnel at a temperature of 99° F.

Salt and water is also frequently ordered for the same purpose. To a pint of water should be added a drachm of salt. This is injected with a catheter and funnel at a temperature varying from 99° to 105° F., according to orders.

Nutrient enemata.—When a patient cannot be fed by mouth, nutrient enemata are frequently ordered.

It is usual now to give them in larger quantities and less often than was formerly the rule.

They are composed of ℥viii to ℥x of peptonised milk, one egg, one ounce of port or brandy, a little salt and a teaspoonful of arrowroot. The whole should be warmed by placing the vessel in a basin of hot water. The enema should be strained before it is given, and should be injected slowly through a catheter and funnel.

The catheter should be well oiled and about six inches of it passed into the rectum.

A nutrient enema of about half a pint would be given three times during the twenty-four hours.

When patients are being fed by nutrient enemata it is usual to wash out the rectum once in the twenty-four hours with warm water. A catheter and funnel is used for this, and the catheter passed into the rectum as described above.

Warm water is then poured into the funnel, which is held high. The funnel is next turned into a vessel lower than the bed, and the water is allowed to run out again. This is repeated several times until the water runs back quite clear.

Before giving a nutrient enema the bowel should be quite clear of fæces, and it is sometimes necessary to give a soap and water enema first.

If this is so, the patient should be left for quite an hour before giving the nutrient, so that the bowel may quiet down.

Milk and beef tea may be peptonised with either Fairchild's peptonising powders or with liquor pancreaticus.

Fairchild's powders are sold in small tubes, one of which is sufficient to peptonise one pint of milk.

The method is as follows: Take one pint of milk and add to it a quarter of a pint of cold water. Divide the mixture into equal parts. Boil the one half, and to the cold half add the powder, seeing that it is well mixed. Add the boiling half of the milk, cover over the jug, and leave it in a warm place from ten minutes to an hour. The longer it peptonises the more bitter it tastes, so that for feeding by mouth twenty minutes is the usual time for it to stand. For rectal feeding in some cases an hour is allowed.

To stop the process the whole is brought to the boil and then set aside to cool.

Instead of being boiled, the mixture may be placed on ice, which also stops the peptonising process, but it is not so satisfactory, as when it is removed from the ice it continues to peptonise.

The method with liquor pancreaticus is the same, except that ʒii of the liquid is used with grs. xxx of bicarbonate of soda, and the milk is peptonised for a longer time, usually for an hour to an hour and a half.

Washing out the stomach.—This is done by the same method as washing out the rectum, except that a large tube is passed down the œsophagus, and that larger quantities of fluid are used, so that the nurse must be careful to have a *large* pail by the side of the bed to receive the returned fluid.

The œsophageal tube should be lubricated with a little butter—olive oil is more apt to make the patient feel sick.

The urine.—The normal quantity of urine passed in the twenty-four hours, as has been stated elsewhere, is about 50 oz.

Frequently a doctor prefers for examination a specimen of urine taken from the whole quantity passed in the twenty-four hours.

When urine has to be saved for inspection the nurse should see that the vessel in which it is put is scrupulously clean, and that it is kept covered.

Urine may be either acid or alkaline. Acid urine turns blue litmus paper red, and alkaline urine turns red litmus paper blue.

The specific gravity of normal urine varies from 1015 to 1025. It is tested by a urinometer.

Urine may contain blood, sugar, albumen, bile, pus, etc., and there are various tests by which the presence of these constituents may be ascertained (p. 160).

The nurse must notice the frequency of micturition, whether there is any pain or difficulty, and the colour and quantity of the urine passed.

In some cases there may be incontinence, and then the patient's back and surrounding parts will need particular attention.

Passing the catheter.—In retention of urine the catheter may have to be passed. In doing this it is necessary to have at hand a measured porringer, a receiver, some sterile olive oil, some swabs and a bowl of antiseptic lotion such as carbolic 1 in 60 or perchloride of mercury 1 in 4,000. The surrounding parts should be washed first with soap and warm water and then thoroughly with disinfectant.

A freshly sterilised catheter should be taken, the eye being dipped in the sterile oil. It should then be gently inserted into the urethra.

Before inserting the eye of the catheter the nurse should be careful to see that the other end of the catheter is in the measured porringer which is placed conveniently near.

After the urine has quite finished running, the catheter is gently withdrawn and placed in the receiver.

The greatest care must be exercised in the cleaning of catheters. To do this they should be held under a freely running tap of water, first with the eye up, then the other end up. and again with the eye up. It must be seen that the water runs *through* and not only round the catheter. Next the catheter should be syringed with either carbolic 1 in 20 or perchloride of mercury 1 in 1,000. It is then boiled for ten minutes in a solution of soda water—one drachm of soda to one pint of water—which must be boiling before the catheter is put in. Afterwards it is dried on a sterilised towel, and the inside may be dried by holding the end for a few minutes over a small spirit lamp. Every catheter should be freshly sterilised before being passed.

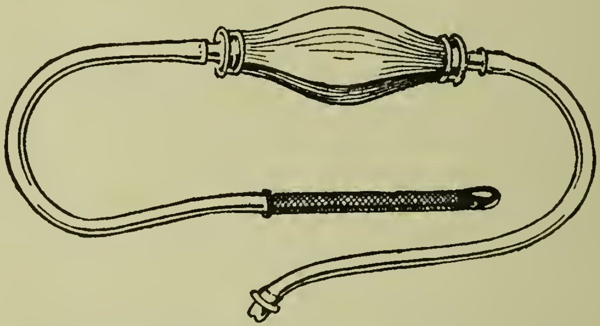

Fig. 55.—Higginson's Syringe with Vaginal Nozzle.

Gum elastic and French catheters cannot be boiled, so they are left to soak in the disinfectant, after being well syringed, for twenty minutes to half an hour.

Washing out the bladder.—To wash out the bladder the greatest care and gentleness are needed. The urine is first drawn off by passing the catheter in the method described above.

Then without withdrawing the catheter, a piece of tubing with a glass funnel at one end is attached to it by means of a short glass tube. The fluid is poured slowly in, the funnel being held higher than the patient, and then the funnel is lowered and the fluid is allowed to escape into a vessel placed to receive it. This is repeated several times, the patient being kept particularly warm both during and after the process, as rigors are apt to occur.

Incontinence and retention.—With incontinence of urine there may be retention, and this should be carefully watched for. The incontinence may be only the dribbling away from an overfull bladder.

Suppression of urine.—This is an extremely serious condition. When this occurs no urine will be passed nor found in the bladder when the catheter is passed.

Vaginal injections.—Vaginal injections are given either with a Higginson's syringe to which a vaginal nozzle has been fixed, or with a vaginal nozzle fixed to a long tube which is attached to a tin pail holding two to three pints, and placed on a bracket above the patient's bed. At the junction of the tube with the pail there is a stop-cock fixed, so that the flow of the fluid may be regulated or stopped as desired.

The patient lies on her back, and is placed on a bedpan or a douche tin made for the purpose.

The vaginal nozzle is now usually made of glass, and is a tube about five or six inches long, with a few perforations round the closed end. It is oiled and gently passed into the vagina, being directed upwards and backwards.

The nurse should see that the utensil receiving the returned fluid is sufficiently large, so that it may not overflow.

The temperature of the water injected may vary from 85° F. to 110° F. or even 115° F. Usually some antiseptic is added to the water. It is as a rule a weak solution, and the nurse should be most careful that the proportion ordered is given.

Hypodermic injections.—A hypodermic injection is one given under the skin, and for this a special syringe is made. It consists of a small glass or metal tube fitted with a piston and a detachable needle.

Drugs are introduced quickly into the system by this method, and as they are generally strong poisons, there must be the greatest accuracy in measuring the prescribed quantity. Morphia, strychnine, caffeine, ether, etc., are some of the drugs most commonly given in this way. Brandy is also sometimes administered hypodermically.

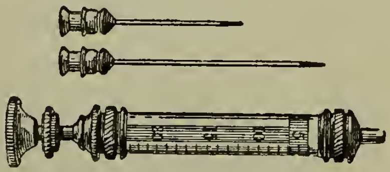

Fig. 56.—HYPODERMIC SYRINGE.

Drugs for hypodermic injections are usually prepared in the form of small tabloids, which can be procured of any strength ordered.

In preparing the injection the needle should be unscrewed, and a few drops of water drawn up into the syringe ; the tabloid is then dropped in, the needle is screwed on again, and the syringe is shaken well to dissolve the tabloid.

The solution should then be brought to the top of the needle, so that no air may be injected.

The spot where the injection is to be given should be rubbed with a swab wrung out of some antiseptic.

The nurse must then pinch up a fold of the flesh and, having dipped the needle of the syringe in sterile oil, must thrust it in, in an upward direction. She should slowly press the piston and inject the solution. In withdrawing the needle she should place her finger for a few seconds on the small puncture and rub gently upwards.

A slightly larger syringe is required for caffeine, which is usually injected into the deeper tissues. A still larger syringe is required for brandy and ether. Most injections are given in the arms or legs.

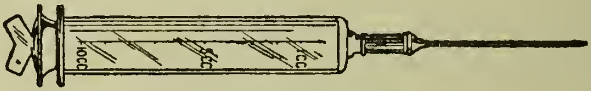

Fig. 57.—Serum Syringe.

Ergot is injected into the buttock, and the needle of the syringe should be plunged straight in. Ether and brandy are generally given in the chest above the breast.

A hypodermic syringe should have some cold water drawn through it after an injection has been made. The needle should be washed in some disinfectant, and a wire put through it, as it is apt to get blocked. Some doctors prefer the needles kept in a solution of equal parts of lysol and methylated spirit.

Serum injections.—Before giving an antitoxin or serum injection, the skin of the area in which it is to be made must be thoroughly washed with soap and water, rubbed with ether, then with biniodide of mercury, which should be thoroughly washed off with an antiseptic lotion.

The serum syringe should be rendered absolutely sterile by boiling just before use.

The site of these injections is usually the lower part of the abdomen towards the side, and if more than one injection is required it should be given into each side alternately.

The injection should be administered slowly, as it is usually rather a large quantity. When the needle is withdrawn the small puncture made by it is sealed with a piece of sterile gauze dipped in collodion.

It is most important that everything in connection with this small operation should be entirely aseptic.

Hæmorrhage.—This subject is to be dealt with more fully in the chapter on Surgical and Accident Nursing, but a few practical hints may be given here.

Hæmorrhage, then, may be arterial or venous, and may be primary, recurrent, or secondary.

Primary hæmorrhage is that which occurs at the time of the accident or operation. Hæmorrhage is called *recurrent* when it occurs from twelve to twenty-four hours after the operation; it may be caused by the slipping of a ligature or from a vessel that had not been tied at the operation beginning to bleed.

Secondary hæmorrhage may occur two, three or more weeks after the accident or operation from the sloughing of the wound into an artery.

Arterial hæmorrhage is bright red in colour, and spurts out in jerks. It is most serious, and if not stopped the patient may bleed to death in a very short time. The nurse must compress the artery at a point nearer the heart than the bleeding point, either with her fingers or with a tourniquet, and a doctor should be sent for immediately.

In *venous* bleeding there is a steady flow, and the blood is darker in colour. The part should be raised; for instance, for a ruptured varicose vein the leg should be well elevated, and pressure should be applied either to the part itself or further away from the heart than the bleeding point.

In *uterine* hæmorrhage the foot of the bed should be well raised on chairs, and usually very hot douches (115° F.) are employed.

In *hæmatemesis*, or bleeding from the stomach, the patient should be kept quite flat on his back.

In *hæmoptysis*, or bleeding from the lung, the patient often finds it a relief to be propped up, to enable him to spit up the blood and to breathe more easily.

In *epistaxis*, or nose bleeding, the nose should be bathed with ice-cold water, or if it is persistent an ice bag may be applied. In severe cases the nostrils may have to be plugged, and the patient should be kept very quiet.

Transfusion is sometimes ordered after a patient has lost a good deal of blood or is suffering from shock.

There are two kinds of transfusion, *intravenous*, where saline solution is introduced directly into a vein, and *continuous*, where the saline solution is injected into the subcutaneous tissues.

For *intravenous transfusion* a special apparatus is required, consisting of :

1. Cannula, to which is attached a piece of rubber tubing with a clip.
2. Glass syringe.
3. Aneurysm needle threaded with silk.
4. Scalpel.
5. Dissecting forceps and scissors.
6. Two or three straight needles threaded with silkworm gut.
7. Swabs, bandages, dressings, mackintosh, turpentine and ether for cleaning the skin.

Three to five pints of the saline solution should be prepared. Boiling and distilled, or cold *boiled*, water must be used, and to each pint of water a drachm of salt must be added. The temperature of the solution should be from 100° F. to 105° F.

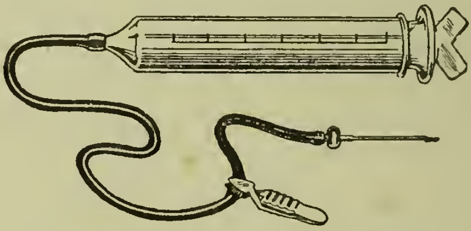

Fig. 58.—Cannula used in Transfusion.

Intravenous transfusion is generally given into one of the superficial veins of the arm, near the bend of the elbow.

The bandage is applied tightly below the point where the incision is to be made. The skin is well cleaned.

The vein is dissected out, and after this is done the aneurysm needle is passed beneath it with the silk ligature.

The cannula (Fig. 58) is introduced into the vein. The syringe is filled with the salt solution, care being taken to expel all air. The nozzle is fitted on to the indiarubber tubing which is attached to the cannula. The clip is removed and the solution is gently injected. When the syringe is emptied, the clip is put on to the tubing to prevent any air entering, the syringe is filled again, and the same process repeated until the required quantity of salt solution has been injected.

The cannula is then removed, the vein is tied, the wound is stitched up and a dressing applied.

For *continuous transfusion* the top bedclothes are divided in half, as they are for a case of vaginal hysterectomy.

The patient's knees are raised by a pillow, and sometimes the foot of the bed is slightly raised by means of blocks.

The patient must be kept very warm with blankets, hot-water tins, etc., as a patient requiring continuous transfusion is usually suffering very greatly from shock. The legs may be wrapped in cotton wool up to the point where the transfusion is to be given.

The sterile saline solution is contained in a glass jar with a narrow neck holding about eight pints (Fig. 60, p. 213). This vessel is placed in a foot bath containing water of 130° F. This will raise the temperature of the saline solution to 110° F., the temperature at which it is usually given. The bath should be placed on a pedestal or table higher than the bed, and standing at the foot of it. In the solution is placed a transfusion thermometer, and the metal end of the syphon tube, which must previously have been boiled. The neck of the jar is then stopped with cotton wool.

The syphon tube is long, with a metal valve, and is bifurcated for about a quarter of its length. Just above the bifurcation is a bulb which is used to fill the tubes with the solution. When the divided tubes are running freely they are clipped quite near the ends by Spencer Wells' artery forceps.

The inner sides of the patient's thighs are cleaned up with ether. The transfusion needles, which must be freshly sterilised, are dipped in sterile oil, and inserted in an upward direction. The tubes are then attached to the needles and tied on with thread. The Spencer Wells forceps are removed, and the solution begins running. Care must be taken that it does not run in more quickly than the patient is absorbing it. If this is happening, one tube may be clipped with the forceps, or each tube may be half shut off by means of the forceps.

Eight, ten or more pints may be given in this way.

When the required quantity has been injected the needles are carefully withdrawn, and the punctures closed with small pieces of cyanide gauze dipped in collodion.

All through the process the nurse must pay close attention to the patient, and to the apparatus. The saline solution must be kept at an even temperature by adding more hot water to the vessel in which the jar is standing.

Administration of medicines.—A nurse is usually responsible for the administration of medicines, and she should be most particular as to the dose and as to regularity.

She should be fully conversant with the table of fluid measurements, readily reading the signs employed for the various quantities.

Poisons should be kept in quite a distinct place from the medicines which are to be given by mouth.

The nurse should always read the label, no matter how familiar she may think she is with it.

Medicines with a thick sediment should be well shaken up, and the dose should not be poured out until the patient is quite ready to take it, and should be measured close to the patient, so that there may be no time for the undissolved ingredients to sink to the bottom of the glass.

Medicine should be poured out from the side opposite to the label, so that any drops running down the bottle may not disfigure the directions.

If the patient's throat and mouth are dry he will taste the medicine much more, so that it is a good plan to let him have a drink of water first. If medicine is very much objected to, the nose may be held while it is being taken; then it will not be tasted.

Preparations of iron and steel are very bad for the teeth, and if the patient objects to taking these medicines through a glass tube, he should be encouraged to clean his teeth after each dose.

A nurse must be careful to have a sufficiently large glass in giving effervescing medicine, and before mixing it she must see that the patient is quite ready to take it.

Castor oil is best given in some fluid, as brandy, lemon juice, coffee or milk, one of the first two generally being preferred.

The glass should be rinsed round with some of the chosen fluid, and some left at the bottom of the glass. The dose of castor oil is then poured carefully into the centre of it, and a little of the same fluid should be poured on the top of the oil.

Some people can take castor oil better if the glass is just warmed with some hot water first.

A drink of hot black coffee afterwards or a morsel of dry bread usually takes away the taste.

Castor oil is best given on an empty stomach.

After the oil has been given the medicine glass should be well washed with soap and hot water, and then rinsed in cold water.

Cold water left standing in the glass takes off any disagreeable odour.

Cod-liver oil should be given directly after food. Iron and arsenic are also given after meals.

Croton oil is a very strong purgative. The dose is from one to two minims. This drug is given on butter, or it may be dropped into a teaspoonful of milk.

A tiny piece of butter should be taken on the end of a spoon, and a dent made in it. Into this the croton oil is dropped. The spoon is placed well back in the patient's mouth, the butter melts off, and slides down the throat.

Cajeput oil, ordered for flatulence, usually in a dose of three minims, is dropped on a lump of sugar.

A cachet should be placed in a spoon and just dipped into some water. The patient can easily swallow it then if a drink of water is given afterwards.

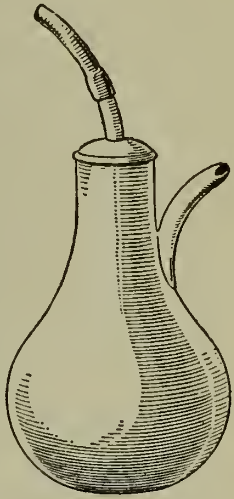

Fig. 59.—An Inhaler.

A pill should be placed on the tongue and a drink of water given, when it usually slips down quite well. A large pill is more easily swallowed than a small one.

A powder may be shaken on to the back of the tongue, and a good drink of water given afterwards. Of course, it may also be mixed with jam or in water.

Inhalation.—Another way of introducing drugs into the system is by inhalation.

Usually the drug is added to boiling water, which is placed in a jug or a vessel with a spout and short tube specially made for the purpose.

The patient puts his mouth to the tube, his head and shoulders being well covered, and breathes in the drug-laden steam. Care should be taken that he is in a comfortable position, and that there is no fear of the vessel being upset and of the patient being scalded.

Powders are sometimes burnt, and the fumes inhaled.

Nitrite of amyl is a very powerful restorative used in some heart cases. The correct dose of this drug is enclosed in a glass capsule, which should be wrapped in a piece of lint, then broken and given to the patient to inhale through the lint.

Absorption.—Drugs are sometimes absorbed through the skin. They are then usually prepared as an ointment or liniment and rubbed in. As these drugs are often powerful, the nurse should be careful not to absorb them herself. A neat contrivance is made of glass in the shape of a flat disc to which there is a handle. By means of this the nurse can rub the ointment in, thus ensuring that the patient gets the full benefit of the quantity of the drug ordered with no harm to herself. Mercury is very often administered locally in this way.

Suppositories are a means of introducing drugs or nourishment *per rectum*. They are usually made in a cone shape. The nurse should oil her finger and the suppository, and pass it as far up the rectum as she conveniently can.

Laying out the dead.—It takes two persons to perform the last duty which falls to a nurse's share when the life of her patient is over.

The body must be laid flat, the limbs straightened, and the pillows and most of the bedclothes removed. It is best to take off any personal clothing before the stiffening sets in. The body must be left decently covered.

The jaw should be tied up with a bandage, a slit being made in it to take the chin, and the mouth being placed in as natural a position as possible. This bandage must not be removed until the jaws are sufficiently set.

The eyes must be closed, and if the nurse places her fingers on the eyelids for a few minutes it will usually be quite sufficient to ensure this. If there is any difficulty a pad of wet lint pressed firmly across will generally be successful.

The body must be left for a little time before it is washed, usually for about one hour.

Often there is a good deal of discharge after death, and the orifices of the body should be closed with cotton wool.

A clean shirt should be put on, and it is more convenient that this should open down the back. Cotton stockings are put on, and the legs should be tied together just above the ankles.

All wounds should be freshly bandaged, and a clean piece of lint put on instead of the dressing.

When the jaws are set the jaw bandage should be taken off, and the hair neatly arranged to make the face look as natural as possible.

When a body is sent from a hospital to the mortuary it is wrapped in a sheet. The ends should be twisted and turned under to avoid using pins, which are a source of danger to the attendants' hands.

Further nursing details of a more special character than those described in this chapter will be found in the chapter on Surgical and Accident Nursing and elsewhere.

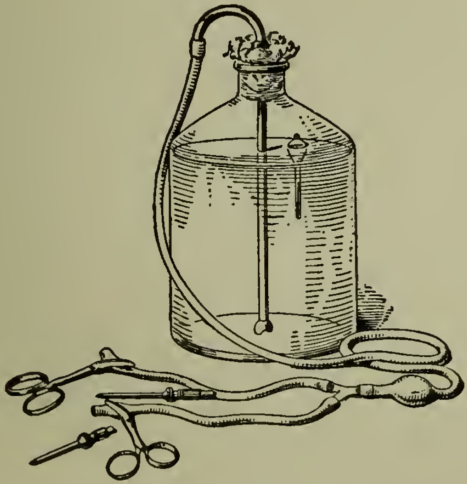

Fig. 60.—Apparatus used for Subcutaneous Transfusion.

CHAPTER XX

THE NURSING OF PHTHISIS

By Helen Todd

Infection—Cleaning of Rooms and Shelters—Sanatorium Life and Treatment—The Patient's Rooms—Shelters—Lounge Chairs—Artificial Heating of Rooms and Shelters—Disinfection and Destruction of Sputum—Bathing—Weighing the Patient—Diet—Temperature and Pulse-taking—Hæmorrhage from the Lungs—Application of Local Remedies—Precautions against Bed-sores—Washing of the Patient's Clothes.

The present-day medical treatment of tubercular disease, and especially of phthisis (pulmonary tuberculosis), chiefly consists, as far as the patient is concerned, of a close observation of the rules of hygiene, of super-alimentation, and of carefully prescribed alternations of rest and graduated exercise in the open air, together with strict attention to the destruction of infective matter.

It is very necessary that the nurse in charge should realise not only the nature of the illness and its causation, but also the rationale of modern treatment, which is not so much to effect a cure by means of drugs and disinfectants, as to husband the patient's strength, and build up his constitution so that his natural forces may be enabled to combat the disease, and eventually gain the victory.

The liability to re-infection, and this very largely from the patient himself, unless the very strictest precautions are taken, is a factor that must never be forgotten or overlooked.

INFECTION

A preventible disease.—Tuberculosis, and especially the pulmonary form, comes under the classification of " preventible disease " ; it is one of the penalties paid by civilised mankind for the ignorance or neglect of the laws of hygiene. Dirt, overcrowding, starvation, drunkenness, and non-ventilation are largely concerned in its production, preparing as they do the favourable "soil" without which the "seed" would probably come to nothing. It is said that by the removal of these conditions the disease could be entirely blotted out.

Method of infection.—Consumption or phthisis is produced by the invasion of the lungs by the tubercle bacillus, a micro-organism which finds its way into the human body by either the respiratory or the alimentary tract—that is, in air that is breathed or in food that is taken.

If the patient is possessed of a fairly strong constitution and the presence of the bacillus is detected before it has had time to do much mischief, or to establish large colonies, the prognosis is generally good, and if the laws of hygiene can be carefully enforced, and the chances of reinfection minimised, he should have every chance of complete recovery. It is of the utmost importance that nurses should realise how amenable to treatment phthisis often proves in its early stages; both in private and district work they frequently come across incipient cases, and while it is certainly no part of a nurse's duty to attempt a diagnosis, she should do all in her power to urge that skilled medical advice be obtained before it be too late.

Dried sputum.—The most general source of tubercular infection is believed to be the sputum of phthisical persons. As long as it is kept damp it is comparatively harmless, but if it be allowed to fall upon the ground it soon dries and is trampled into fine dust, which, stirred up by wind or by traffic, is suspended in the air, and so inhaled. Expectoration received upon handkerchiefs is almost equally dangerous; it is soon dried by the warmth of the pocket, and when next the handkerchief is used the dangerous dust is shaken off and so disseminated. The same holds good of handkerchiefs which, after being used, are placed under the pillow by patients in bed.

Sun's rays as a germicide.—Fortunately sunlight has a strong germicidal effect upon the tubercle bacillus, and it has been proved by Dr. Arthur Ransome and Professor Delpine* that specimens "exposed to both light and air even for two days only, and for *one hour of sunshine*, were found to have lost their power for evil. . . . These times of exposure to either light or air were less than would suffice for the pulverisation of sputum under ordinary circumstances. . . . These tests were much more severe than would be found under ordinary circumstances." On the other hand, Dr. Ransome has also published the results of other investigations, showing the long retention—some months—of their virulence by bacilli in ordinary cottages where consumptive patients had been living; and Dr. Coates, of Manchester, states that the dust collected from situations near the floor, i.e. within two feet, is much more dangerous than that found at a higher level; hence the need for very great care in cleansing the floors and wainscoting of rooms inhabited by phthisical persons. (*See* pp. 221–22.)

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* Ransome's "Treatment of Phthisis."

Food as a source of infection.—It is a well-known fact that cattle and swine are peculiarly susceptible to some forms of tuberculosis. The tubercle bacillus has been repeatedly found in the flesh of these animals, and its presence demonstrated in the milk drawn from tuberculous cows. Many authorities hold that this disease in children is very largely due to the ingestion of contaminated milk, and strongly urge that all milk given to children should first be sterilised by heat. As boiling is believed to lessen the nutritive value of milk considerably, the determination of the thermal death point of the tubercle bacillus is of considerable interest to nurses. Professor Bary has published the results of experiments showing that cultures of tubercle bacilli in bouillon enclosed in tubes were rendered sterile by being subjected for *five* minutes to a temperature of 65° C. (149° F.), and that tubercular milk heated to 70° C. (158° F.) lost its infective powers, giving negative results when injected into the peritoneal cavity of rabbits.

These experiments were, however, carried out under laboratory conditions, and the Professor recommends for practical use the heating of the milk to 80° C. or 85° C. (176° F. or 185° F.) in order to ensure the destruction of any tubercle bacilli which it may contain. In his "Lessons on Disinfection and Sterilisation," Dr. Andrewes points out that the tubercle bacillus differs from true bacteria "in its thermal death point. It is inferior in its resistance to true bacterial spores, but resists heat better than ordinary non-sporing bacteria." He states that an exposure of ten minutes to a heat of 170° F. is sufficient to kill ordinary bacteria, whereas "true spores require exposure to 212° F. for a time varying . . . . from a minute or two up to half-an-hour for their certain destruction."

The question whether the tubercle bacillus forms spores is still undecided, and meanwhile the safest plan is to treat it as though it were included in that class.

It must be remembered that moist heat is a far more efficient germicide than dry heat, and "boiling" is therefore much more efficacious than "baking" for the purposes of disinfection.

CLEANING OF ROOMS AND SHELTERS

It is important to realise that the presence of dust is dangerous to a phthisical person, not only on account of fresh infection from the bacilli which it may contain, but also because of its irritating effect upon the already damaged lungs and susceptible air passages. All cleaning or "dusting" must therefore be done in such a manner that every particle of dust is *removed*, and not merely disturbed to settle elsewhere.

Damp cleaning.—As far as possible washing should take the place of sweeping—for instance, where the floor is polished or covered with linoleum. In carpeted rooms, and for heavy rugs, where sweeping is necessary, plenty of wet tea-leaves or damp sawdust should be used, in order to prevent the dust from rising into the air. All dusting should be done with cloths or sponges wrung out in boiling water, and surfaces must be wiped, not "flicked." Dry dusters should only be employed to restore the polish on the articles so wiped over.

The dusters should be boiled for twenty minutes each day after use, and brushes and sponges soaked in carbolic acid (1 in 20). All ledges, such as door panels and the mouldings on skirting boards, must have special daily attention, as also should the ledges on the bedstead (round the mattress) and the projections on its frame; it is surprising how often these escape the vigilance of the nurse.

If possible the floor should be wiped over every morning.

Patients should never, unless bedridden, be in the room whilst it is being swept or dusted, or when the bed is being made. Every care must be taken to prevent the inhalation on their part of any dust.

The bed should on no account be in a corner of the room. Air should circulate freely round it, and space should be allowed for cleaning the floor on both sides of it.

SANATORIUM LIFE AND TREATMENT

"A course of sanatorium treatment" is the usual prescription given nowadays to a patient discovered to be suffering from phthisis; if he be wealthy enough he will probably be advised to make a stay of long duration, and to remain until the disease is arrested; but if this be impossible for lack of means, he ought to learn enough of the treatment in two or three months to be able to carry it on privately under medical supervision.

Sanatorium life in this country is very largely modelled on the Continental system as introduced by Dr. Walter of Nordrach, and the arrangements in the best private and public sanatoria will be found to differ but little, although, of course, the appointments and the service in an institution charging from four to eight guineas a week are very different from those where the patient is not expected to pay more than 7s. 6d. or 10s.

Time table.—The time table at the Royal National Sanatorium for Consumption at Bournemouth is very typical of the latter class of institution. It runs as follows:

HOURS.	
6.30 A.M.	Patient's temperature taken by the night nurse.
7 A.M.	½ pint of hot milk served.
7.45 A.M.	Patients whose temperature was not above 99.8° the evening before, or 99° that morning, rise and get dressed slowly.
8.30 A.M.	Breakfast, followed by prayers, and then rest in the open air on specially constructed lounge chairs. Doctor's visit.
10.30 A.M.	Hot milk, ½ pint. Exercise as prescribed for each patient.
12 NOON.	Rest on the lounges in the open air.
12.30 P.M.	Dinner.
1 to 2 P.M.	Rest as above.
2 to 4.30 P.M. ..	Exercise as prescribed.
3.30 P.M.	Hot milk, ½ pint.
4.30 to 5.15 P.M. ..	Rest.
5.15 P.M.	Tea.
5.45 to 6 P.M. ..	Rest.
6 P.M.	Temperature taking.
6.20 to 7.20 P.M. ..	Card games, billiards, etc., for those with permission from the medical officer to play.
7.20 P.M.	Supper.
8 P.M.	Prayers and bed.
9.15 P.M.	½ pint of hot milk taken to each patient.
9.30 P.M.	Lights out.

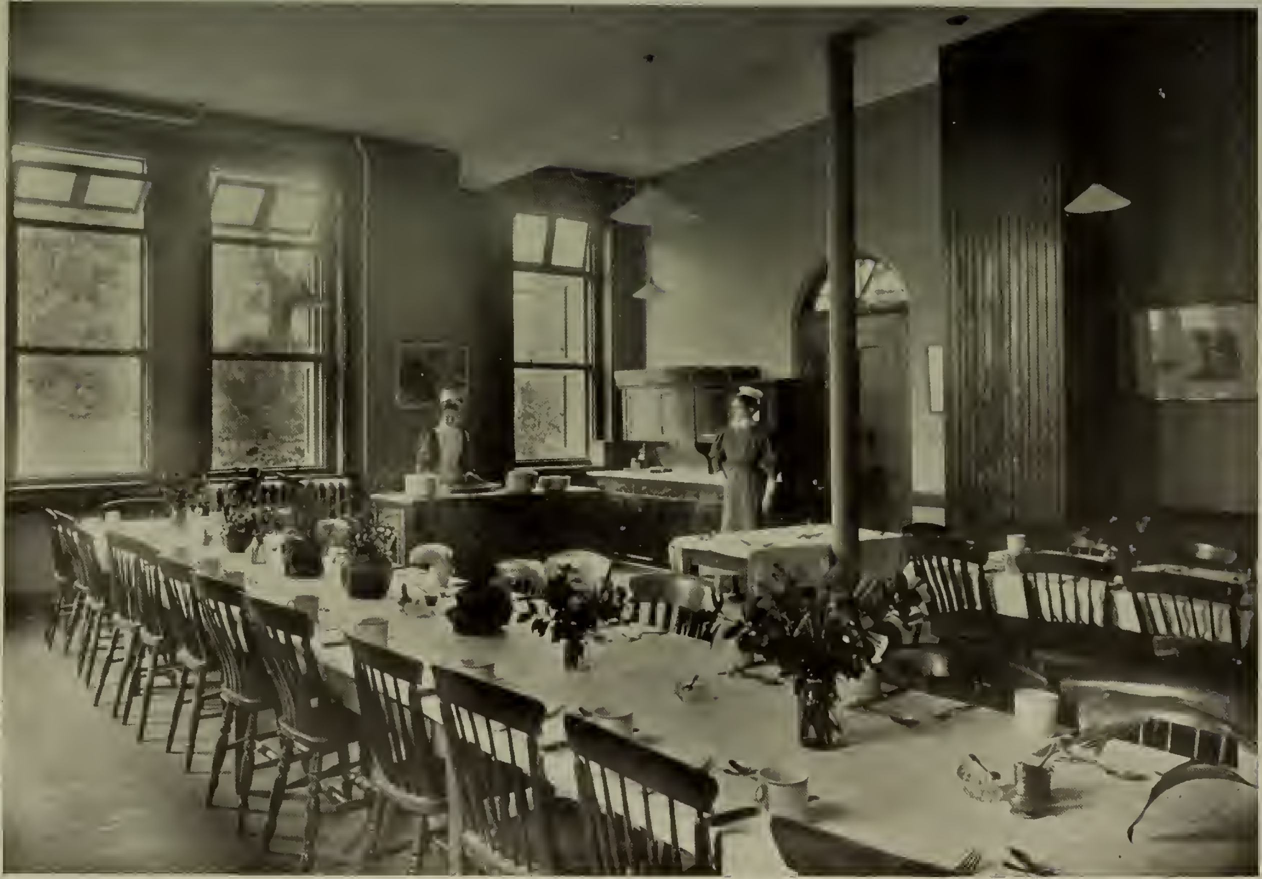

Photo: Buchanan & Co.

PLATE XXXII.—MEN'S DINING ROOM, ROYAL NATIONAL SANATORIUM, BOURNEMOUTH.

During the night patients are regularly visited by the night nurses, and to those awake cocoa and hot milk are given.

Exercise.—In the Royal National Sanatorium the exercise consists of graduated walks in the grounds and neighbourhood, patients being instructed to go slowly uphill on starting, so as to have the return journey downhill, when they are feeling tired.

Croquet, and putting on a "golf clock," have here, too, been found most excellent means of mild exercise, whilst for patients fit for rather less exertion and who have not suffered from hæmoptysis, billiards and bagatelle are useful.

As the patients improve and the medical staff consider them able, they are employed in light gardening tasks, such as sweeping the paths, rolling (with light roller) the lawns, and helping to mow them.

Unexacting occupations.—Such occupations as chess, netting hammocks, and, with the women, needlework, are at Bournemouth much encouraged, it being recognised that there is a distinct danger of helping to create a class of sanatorium loafers, men who have found life so comfortable in charitable institutions that, even after they have ceased to require medical treatment, they will endeavour to gain admission, or, failing that, live valetudinarian lives at home, supported by their unfortunate wives.

THE PATIENT'S ROOMS

As phthisis is not a disease which runs a short or definite course, and as our patient will most likely inhabit his rooms for some months, it is well worth while taking special pains in choosing them, in fitting them up, and, if necessary, making such structural changes as the re-hanging or the enlarging of the windows.

Aspect of rooms.—The rooms should have a south-easterly or even due south-east aspect, thus catching the morning sunlight, which is far more important than that later in the day. A patient confined to one room with a westerly outlook generally finds the afternoon and evening sun very trying, particularly in summer time. The windows should not immediately face a road, on account of the dust caused by traffic, especially by motors; if possible a bedroom and adjoining sitting-room on the ground floor should be selected, thus obviating the necessity of climbing stairs, a hazardous proceeding in advanced cases, where the heart is affected, or where there is a tendency to hæmoptysis.

Windows.—In choosing the rooms the nurse must bear in mind not only the aspect required, but also the importance of there being ample window space—ideally the whole of one side of the room. Sash windows should, if possible, be taken out, and those of the French or casement type substituted.

The best pattern is that in which the casements are divided horizontally as well as vertically (so that when the patient is engaged in his toilet the lower part can be closed), and have a fanlight above, hung on a central pivot, as shown in the diagram (Fig. 61). If the casements are made to open into the room *instead* of outwards, as is so often the case, the great annoyance of their rattling and squeaking on a windy night will be avoided

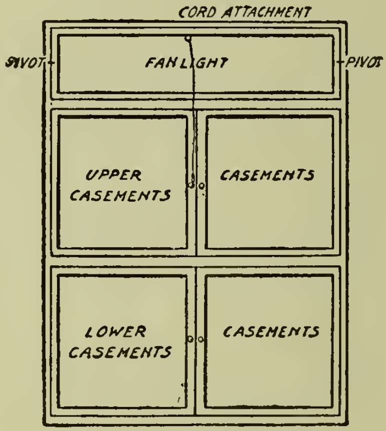

Fig. 61. Casements.

—a most important matter for a light sleeper. It is very desirable, if it be practicable, to carry the window right up to the ceiling, and thus prevent the accumulation of foul and heated air above the window level at the top of a room.

Ventilation.—In building a room or shelter for a phthisical person provision should be made for cross ventilation (a fanlight over the door is usually the most convenient form), but in an ordinary house where this does not exist, the nurse must do what she can by utilising the door and the windows in the hall or on the landing outside the room. The fireplace is a great aid to ventilation. No form of obstruction in the chimney can be tolerated; the register must always be kept open. In cold weather the fire will be a means of providing not only heat but also ventilation.

Artificial lighting.—Electric light is the best of the artificial forms of lighting. It does not load the air with the products of combustion and deprive it of oxygen as do gas, candles, and oil lamps: it is also free from the danger of being blown out by the unavoidable draughts caused by open windows.

Doors.—Banging doors on a windy day are a frequent source of annoyance in a house or institution where open-air treatment is carried out. The best preventive is to have each door fitted with a horizontal hook (attached by a plate screwed to the lower part of the frame), and a staple screwed into the floor in such a position that it will hold the door securely when it is wide open (Fig. 62). On no account should strips of felt be nailed to the framing to deaden sound. If a buffer be required, a small piece of india-rubber tubing, about an inch long, and secured in the middle with a tin-tack. will serve admirably, and can easily be kept clean.

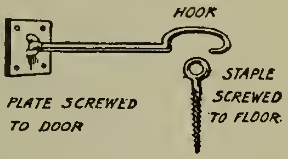

Fig. 62.—ARRANGEMENT TO PREVENT DOOR FROM BANGING.

Another device to prevent a door from banging while the nurse is going in and out of a room (presumably with her hands full), is to have a small roller cushion about 13 inches long, and 8 inches in diameter, with tape loops one at either end, to be put over the door handles, one inside and the other outside the room.

Floors.—If the floors are parqueted or *very* well laid, with no gaps for dust between the boards, they should be well polished with Ronuk or some other sanitary polish, but if, as is usual, there are spaces between the boards, or if these are inclined to roughen or splinter, the floor should be covered with a *good* washing cork linoleum—not the open-pored variety, but one of a close, firm texture. This should be kept polished. Care must be taken that the linoleum is a well-seasoned one, and that it fits well into corners, otherwise it will shrink when washed and leave gaps, proving veritable dust traps, at the joinings and edges.

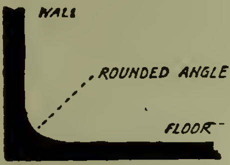

Fig. 63.—ROUNDED ANGLE TO WALL AND FLOOR.

In a properly constructed sanatorium, where the rooms have rounded corners (Fig. 63), no form of floor covering will be found satisfactory, as nothing can be made to fit accurately the concave joining of the wall and floor without leaving a space between. In such a building the floor must be either of wood, kept well polished, or of tarrazio, the cheaper granolith, or some such material.

Walls.—The walls should be without ledges or uneven surfaces, such as cornices and dado or picture rails, where dust may lodge; if these already exist great care must be taken that they are kept scrupulously clean. The same idea of plane surfaces should be applied to all woodwork, and if the windows have to be altered from sashes to casements it is advisable to have these made without any mouldings, the edges and corners being rounded rather than squared.

If the patient does not object to plain colours the walls should be painted or distempered with a washable distemper (these can now be obtained in pretty, soft shades), but as he will probably live in the room for some considerable period, the effect of his surroundings upon his mental condition must be taken into consideration. His taste, therefore, should be consulted, and if he prefers a cheerful paper there is no need to raise any objection, provided it has a smooth surface, and not a roughened one to which dust will cling.

Pictures, and how to hang them.—A few pictures also can be allowed. They should be hung in such a manner that they can be dusted every morning, and have their backs duly attended to, otherwise they will collect dust. Pictures should not be hung by cords, or they will flap noisily on a windy day, and the lower corners will disfigure the wall surface; the best method is to hang the metal rings themselves (which are always screwed on to picture frames as attachment for cords) on to brass-headed nails without the customary medium of wire or cord. Pictures so hung are easily taken down for cleaning.

Blinds and hangings.—Venetian blinds are intolerable, both on account of the number of ledges which they afford as resting places for dust, and also because of their annoying trick of flapping on a windy night.

As few hangings as possible should be permitted, but here again personal idiosyncrasies must be taken into account. Thus, if the patient be a lady and accustomed to pretty and dainty surroundings, the mental effect of a bare and barrack-like abode will be depressing, and will react to a certain extent on her physical condition. Chintz curtains will help to obviate this, but they must be frequently sent to the laundry, not allowed to collect any dust, and must be hung in such a manner as not to interfere at all with the free entrance of sun and air.

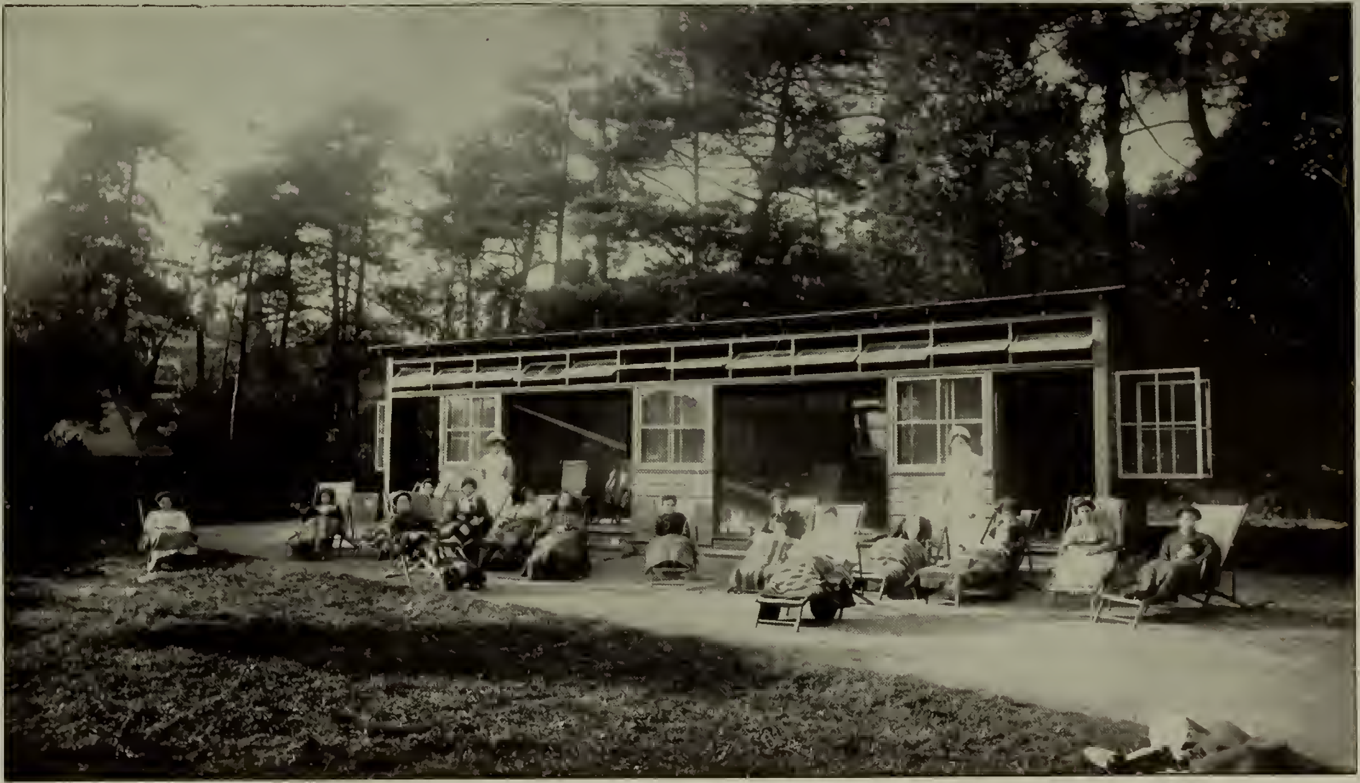

PLATE XXXIII.—SHELTER IN THE GROUNDS OF THE ROYAL NATIONAL SANATORIUM, BOURNEMOUTH, SHOWING AIR-SPACE UNDER THE EAVES AND FANLIGHTS BELOW.

Furniture.—All stuffed furniture and cushions must have removable and washable covers. Buttoned upholstery and basket chairs, with their innumerable interstices which cannot be cleaned, must be strictly tabooed.

All furniture should be light and easily movable, in order that the wainscot behind and the floor beneath may be kept clean. It should, like most of the eighteenth-century chests of drawers, etc., be raised on feet about ten inches high. Wardrobes should have their tops constructed to slope from behind, so that they can be dusted with a damp cloth or broom each morning (Fig. 64).

China ornaments are the best for the chimney-piece; they must, of course, be kept scrupulously clean. Photograph frames should be plain, and of a material that will not be harmed by a daily dusting with a damp cloth.

Flowers and plants are as a rule greatly appreciated; they do much to help in brightening up an invalid's room.

Eiderdown quilts, etc.—Eiderdown quilts should be discouraged; forming as they do the top covering of the bed they are very liable to become sources of infection, or even re-infection for the patient himself, and this especially if there be much cough and he has been confined to bed. The same objection, viz., the keeping of them "clean" in the technical sense, applies to heavy rugs and furs for use when the patient is resting out of doors, and the practice of giving away to the poor such clothing (without disinfection) when it has been worn by phthisical persons is one that cannot be too strongly condemned.

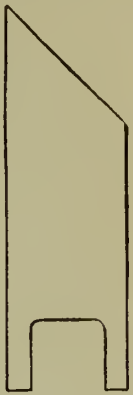

Fig. 64.—Wardrobe with Sloping Top: End View.

SHELTERS

The English climate necessitates the use of some form of "shelter" in carrying out open-air treatment, and although the planning of this scarcely comes within the province of a nurse, she may be consulted as to the best pattern, and, if the patient is to be nursed at home, as to the selection and preparation of his rooms.

It should be clearly understood that the use of a "shelter" is only permissible in wet and stormy weather. No matter how well it may be ventilated, the air inside can never be as pure as that outside, and in spite of every effort in its plan and construction there is sure to be some corner where the sun's rays do not penetrate.

Size.—The "shelter" should be just large enough to hold a bedstead, a table and a chair—9 feet by 12 feet is a useful size. It is better to have a fixed structure provided with windows the whole way round which can be regulated according to the direction of the wind, etc., rather than one of the revolving pattern, which must take some force to move, and will therefore be unsatisfactory in showery and squally weather. The door should be constructed to open outwards.

Roof.—The roof should be well raised from the walls (attachment at the corners will be found sufficient), leaving below the roof a free air space of about 6 inches sheltered by eaves (*see* Plate XXXIII.). This is by far the most satisfactory manner of providing ventilation under the roof. The roof of the shelter should slant from the south-west; this will tend to modify the heat in summer, on account of the angle at which the sun's rays strike the roof. A covering of "ruberoid" will also prove useful in this respect.

Floor.—The floor should be well raised from the ground (Plate XXXIII.), and provision made for plenty of ventilation underneath; its surface should be well oiled, and of course kept perfectly clean. A mat or two will provide all that is necessary in the way of floor covering.

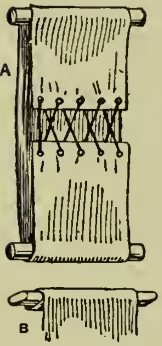

Fig. 65.—A, Writer's Method of Attaching Sailcloth to Lounge Chair. B, Old Method of Nailing the Canvas to the Frame.

LOUNGE CHAIRS

The selection of a lounge chair is a matter of some importance, as the patient will spend a considerable amount of time in it. Many of the adjustable couches are comfortable, but they are too cumbersome and heavy to lift about, and the same objection holds with regard to the otherwise admirable iron-framed "Crosby" chair.

After many experiments a lounge chair was made to the present writer's pattern by Messrs. Allen & Co., of Bournemouth, for the Royal National Sanatorium, and it has been found to answer very well, its chief merits being its simplicity, durability, and facilities for cleaning.

The chief advantages of this lounge, which is made on much the same pattern as a deck chair, are its extreme length, allowing for a hot-water bottle at the feet of a reclining patient, its rounded and stout framework, and the method of attaching the sailcloth—which is used on account of its durability, and because it stands scrubbing—to the frame (Fig. 65).

The following are the exact measurements of a chair for adults (Fig. 66):—

(A) Length 52 in., girth 6 in.
(B) Length 24 in., girth 6 in.
(C) Length 47 in., girth 6 in.
(D) Length 17 in., width 3½ in., flat surface on top to hold a mug.
(E) Length 28 in., girth 5 in.
(F) Metal joint, leaving 4 in. space between ends of C and E.
(G) Length 14 in., girth 5 in.
(H) Length 18½ in.
Length of sailcloth for seat 94 in., width 15 in. Length for foot rest 50 in., width 14 in.
(N) Length of roller cross-bars 18½ in., girth 4½ in.
(K) Length 7 in.

Fig. 65, A, shows how the sailcloth, forming the back and seat of the chair, is laced over the rounded bars forming the cross-pieces. The round shape of these cross-bars causes the sailcloth to move a little when the patient sits down, and so prevents it from wearing thin in any one place.

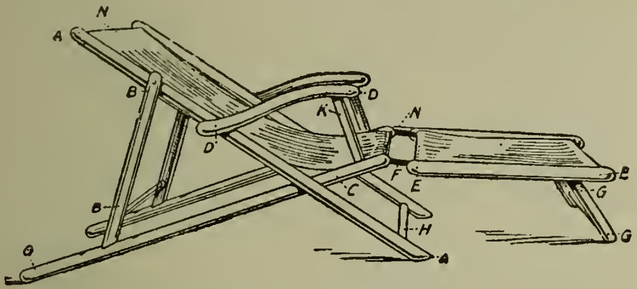

Fig. 66.—LOUNGE CHAIR DESIGNED BY THE WRITER.
(By permission of the Editor of the "British Journal of Nursing.")

ARTIFICIAL HEATING OF ROOMS AND SHELTERS

Generally speaking, the air breathed by a patient should approximate in temperature to that out of doors, but artificial heating is necessary in very cold weather, whilst patients are dressing or undressing, when they are being subjected to medical examination, and in the dining-hall during meals, especially at breakfast time.

Steam-heated floors.—In King Edward VII.'s Sanatorium at Midhurst the experiment has been made of warming the dining-hall and chapel by means of steam-heated pipes running under the floors in pipe channels, the air in which, being thus made exceedingly hot, heats the stone floors in something the same manner as the old Roman hypocaust. The system is said to be most satisfactory, but is too costly and elaborate to be generally applicable either to private or to institutional use.

Radiators.—In sanatoria radiators are generally provided, but in the majority of private houses open fire-places must be relied upon for the production of artificial heat.

Gas stoves are not advisable; they can only be permitted in the bath-room, where they will be found useful.

There is no objection to electric radiators, and for a shelter they are most valuable, but the cost of the current prohibits them to all but the wealthy.

Method of using artificial heat.—It will be the nurse's duty to see that half-an-hour or so before the patient rises in the morning, goes into the dining-room for his breakfast, or retires to bed, the fire is burning well, the radiator turned on, and the temperature of the room thus raised to about 50° F.

Before bedtime (if the patient be not in the room) and before meals are served in the dining-room, the windows may be closed to facilitate the heating, but once he is in bed or seated at the dining-table, the windows must be thrown open to the very farthest extent, and the radiators should be turned off, unless the weather be very cold.

This preliminary heating of rooms, if faithfully carried out, will be found a great preventive of the distressing paroxysm of cough which in many persons is apt to be induced by entering a room much cooler than that which they have just left.

Patients suffering from bronchial or throat complications cannot stand the cold air like persons suffering from uncomplicated phthisis. Their beds should be placed in a more sheltered position, they must keep out of cold winds and excessive draughts, and the temperature of their rooms should not be allowed to fall below 50° F.

For persons inclined to hæmoptysis the cooler the room is kept the better.

It is important that in every case care should be taken to shut the windows while a patient is having his bed made or is being washed.

DISINFECTION AND DESTRUCTION OF SPUTUM.

Pocket spittoons or "flasks."—One of the nurse's most difficult, but at the same time most important duties, especially when working amongst uneducated and ignorant consumptive patients, is to teach them the dangers of promiscuous spitting, and to see that all expectoration is properly disinfected and destroyed. Every phthisical person who expectorates must be supplied with a pocket spittoon. These can be obtained of various sizes and patterns from any chemist; those known as "Dettweiler's" (Fig. 67, A) are undoubtedly the best at present on the market; they are made after the pattern of an unspillable inkstand, but the collar and spring top as well as the screw to the lower aperture are of a heavy metal, and the whole is somewhat clumsy. These flasks have two great merits: they have no corners where particles of sputum can lodge, and when the metal ends are unscrewed they can be easily and thoroughly cleaned. The rubber washers, too, are cheap and simple to adjust.

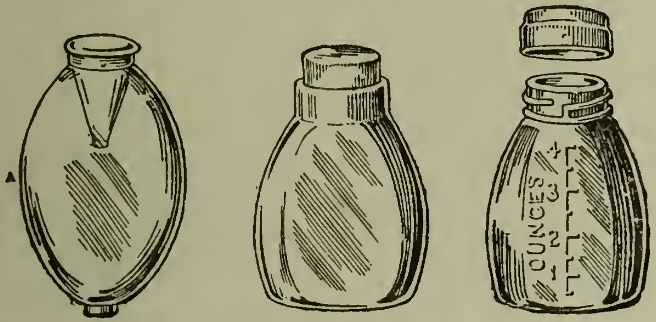

Fig. 67.—Pocket Spittoons.

The other flasks shown (Fig. 67) answer very well, and, being without metal springs to corrode, stand the action of disinfectants and boiling better than do those of the more elaborate pattern. They are also less expensive.

Expectoration mugs for bedside use.—For use in bed at night, and for patients who are very ill, the ordinary hospital mug pattern is the best; it is not so liable to be knocked over as a flask, and, the aperture being so much larger, is far more convenient for a feeble or helpless patient to use.

Papier-mâché or cardboard linings to the mugs can be had for a few pence; these, with their contents, are lifted out of the mug with a pair of forceps, and so burnt without any unpleasantness to the patient or his attendant.

Dr. Niven, the Medical Officer of Health for Manchester, has introduced for bedside use, for poor consumptives nursed at home, cardboard boxes, which have been painted over by hand with a spirit varnish, and then coated inside with tar; this makes them quite waterproof, and, in consequence of the tar, not only do they deodorise the sputa, but they also burn very readily. These boxes, which cost less than a halfpenny each, are supplied free to the consumptives of Manchester by Dr. Niven, with instructions that one be used for about twenty-four hours, and then burnt with its contents. Pieces of waxed tissue paper are also supplied gratis for wiping the lips after coughing. Directions are given that each piece of paper "should be burnt directly after use, or placed in a suitable receptacle until it can be destroyed."

All expectoration should be kept damp until it can be destroyed. This destruction should be by burning, and it may be readily facilitated by first mixing sawdust with the sputum.

Disinfectants for expectoration.—Some form of disinfectant fluid should be kept in the "flask" or spittoon. *Carbolic acid* (1 in 20) is the most usual, and can generally be obtained free from the sanitary authorities by those too poor to provide it for themselves. The various preparations of *mercury*, such as biniodide and perchloride, are not so good as carbolic (or *izal*), for the albuminous constituents of the sputa enter into chemical combination with the mercury, and to a very large extent neutralise its disinfecting powers.

Most authorities agree in recommending a 2 per cent. solution of *chlorinated lime* as an efficient germicide, and in private houses where, on account of gas stoves, or in summer for lack of fires, it is impossible to burn expectoration, it may be rendered harmless by being mixed with an equal quantity of the solution, and then buried or emptied down a drain.

The flasks or sputum mugs should be boiled daily; the addition of soda to boiling water raises its temperature, and so assists sterilisation. The boiling should be for at least 30 minutes.

Paper handkerchiefs.—A consumptive patient should always be supplied with paper instead of linen handkerchiefs, and they must always

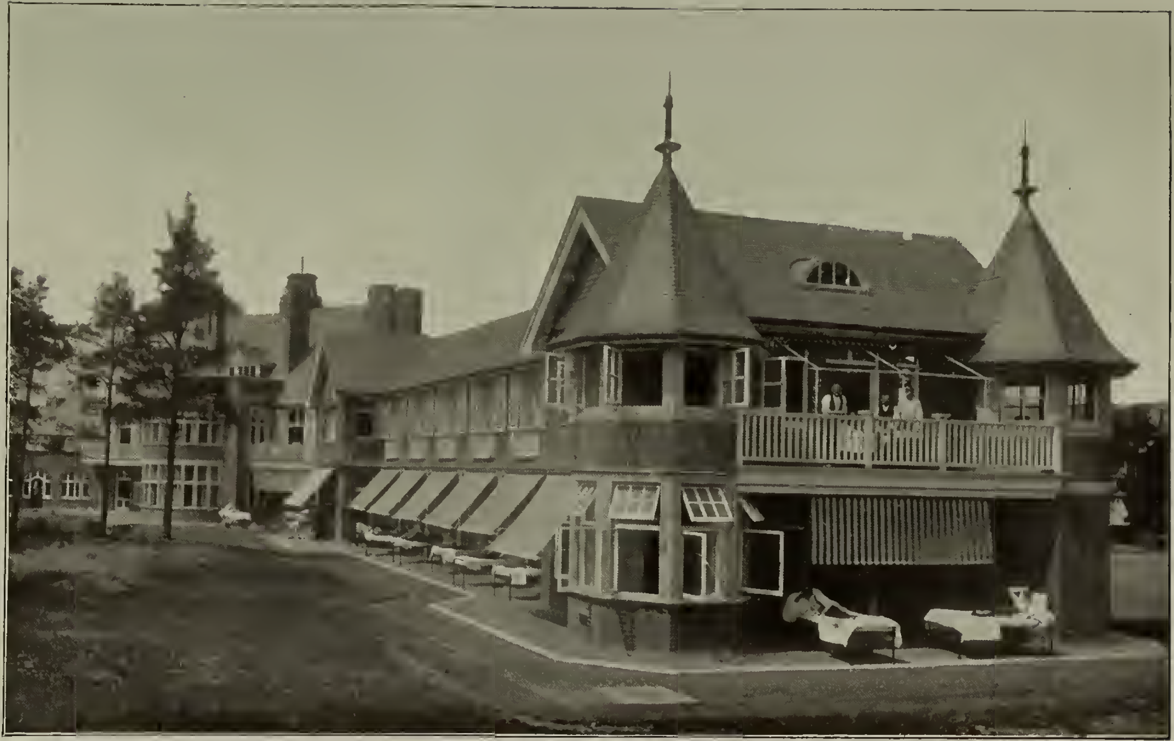

PLATE XXXIV.—ONE OF THE FOUR RADIAL PAVILIONS AT THE SANATORIUM AND CONVALESCENT HOME OF THE BROMPTON HOSPITAL, NEAR FRIMLEY, SURREY.

be burnt *immediately* after use. They can be obtained from any chemist for about a shilling a hundred. Butter muslin forms a cheap substitute for handkerchiefs for patients who object to using paper.

Neither flasks nor handkerchiefs should be placed in the pocket, which they would soon convert into a breeding ground for fresh infection. They must be kept in cotton bags, which should be thoroughly well boiled every evening. A small enamelled basin should stand on the table by the bedside as a receptacle for the handkerchief at night.

Special toilet precautions.—The finger nails should be kept very short and scrupulously clean. They should be well scrubbed before each meal in case any invisible particle of infective matter may have been left on them after a fit of coughing, or the handling of a flask or handkerchief.

Male patients should be taught to be especially careful as to the cleanliness of moustaches and beards, but to remove these is really the only safe method of dealing with them.

Paper serviettes.—Paper serviettes should always be supplied in the place of ordinary linen ones at meal times.

If the patient is being nursed at home the nurse should be careful to see that his implements and utensils for eating and drinking be kept apart from those used by the rest of the family, washed up in a separate bowl, dried with a separate towel, and frequently disinfected by boiling or otherwise.

Unwise habits.—The district nurse will find it necessary to caution consumptive mothers against tasting their babies' food with the child's spoon, or, worse still, sucking the bottle to make the teat "draw."

Kissing a consumptive person, or being kissed by one, is a highly dangerous practice, and should be strictly forbidden.

Other obviously unwise habits are the sucking and biting of pencil and pen tops, and the moistening of the thumb or finger with saliva when turning over papers or the leaves of a book.

The act of coughing projects into the air a fine spray, which, in the case of a sufferer from phthisis, will most probably be laden with infective particles. On this account a patient should be cautious to hold a proper handkerchief (not the hand or a book which he may happen to be reading) before his mouth during a fit of coughing.

Disinfection of rooms, etc., after death.—After a death from tubercular disease the room should be disinfected in the same manner as after an infectious fever. The walls, if papered, should be stripped, the ceilings whitewashed, the room and its contents disinfected with sulphur, everything possible scrubbed with carbolic (1 in 20); the mattress, pillows, and woollen articles, such as blankets and rugs, disinfected by heat, and all articles (linen clothing, metal and earthenware goods) that will stand the process thoroughly well boiled.

BATHING

Many tuberculous persons sweat profusely, and as the skin acts to a certain extent as a compensating organ to the lungs, it is necessary to pay special attention to the bathing of such patients.

Hydropathy forms an important part of the present-day treatment of phthisis, and many of the modern sanatoria are fitted up with elaborate douches, shower and needle baths of every description. These are used under medical supervision, and the nurse is expected to see that her patient undergoes no exertion during the process, and especially during the drying, when rough or hasty movements may start a cough or even cause hæmoptysis.

Bathing caps.—Ladies using these baths will find a bathing cap very useful, saving as it will the great annoyance of getting long hair wet day by day. In private practice many physicians order a morning bath of cold water to those patients who can stand it, relying on the nurse to report if it be not well borne. She must therefore be on the alert to notice such symptoms as blueness, deadness of the fingers, a feeling of chilliness after the bath, any increase of cough or signs of dyspnœa. If such occur, a tepid bath, temperature to range from 99° to 99.8° F., will probably be substituted for the cold one.

Many patients prefer the warm bath in the evening when retiring to bed; whenever it is taken the patient should be warned not to hurry in his movements, for fear of bringing on an attack of coughing.

Special precautions.—As the undressing, bathing, and drying may be a long process, the nurse should see that water of the right temperature is prepared, that the bath-room is not too cold, and that the windows are closed, or nearly so, before the patient enters. If there be any streaks of colour in the patient's sputum during the previous twenty-four hours the nurse must on no account allow him to get into the bath without permission from the doctor.

Bedridden patients.—Bedridden cases should have a "bed bath" between blankets every evening, unless orders have been given to the contrary.

After a heavy night sweat the patient should be sponged with tepid water, gently rubbed with a warm, soft towel, and then given a fresh and warm nightshirt.

A little Scrubb's ammonia in the water or some eau-de-Cologne will help to make the bath refreshing, and this especially in cases where there is much perspiration. Vinegar has much the same effect on the skin as eau-de-Cologne, but to many persons its strong smell is objectionable.

A patient should always be dissuaded from remaining more than five to eight minutes in a bath, and from having the water above 105° F.

WEIGHING THE PATIENT

The weekly weighing of the patient, when properly carried out, is of the utmost diagnostic and prognostic value to the physician. It is extremely important for reasons of comparison that it take place not only at regular intervals, usually weekly, but also at the *same hour of the day* on each occasion. All persons vary considerably at different periods of the twenty-four hours; some show a difference of 1 lb. to 2 lb., or even more, between their morning and evening weight.

Method.—The best method of obtaining the exact weight is first to weigh the patient's night clothes, then himself clad in them only, and before recording the amount registered to deduct the weight of the garments.

The charted weight curve of many persons is very considerably affected by the weather. Thus a sudden cold snap or an unexpected spell of north or east winds will often check a steady increase, and this although the food consumed may actually be more than before the loss in weight.

Very hot weather, too, will reduce weight by inducing perspiration and loss of appetite.

The knowledge that his weight is well maintained has generally a most beneficial effect upon a patient, and does much to stir him up to fresh exertion. Conversely a nurse will find that she needs all her tact in weighing neurotic subjects, and those who are not doing well. It is not advisable to depress their spirits and excite their apprehensions by informing them that the scales are showing an adverse record.

Effect of temperature upon weight.—As may be supposed, body temperature has a great effect on weight; a patient with an evening temperature averaging 101° F. almost invariably loses steadily, although he may be taking nourishment well in both solid and liquid form.

DIET

All forms of tuberculosis, and especially consumption, are "wasting diseases," and one of the chief difficulties in nursing consumptive patients has always been to induce them to take a sufficient quantity of nourishing food.

Generally speaking this wasting is one of the first symptoms of phthisis, and it is this, combined with cough, that has caused the patient to seek medical advice.

It will be readily understood that, should the loss of weight be allowed to continue unchecked, the patient's natural resisting power to the disease will be lessened, and his chances of recovery diminished. Not only so, but, should the illness take an acute turn, he will have no reserve of strength to fall back upon.

"The physician's aim, therefore, is first to increase the patient's weight to about half a stone above what it should normally scale (so as to give him as it were a reserve), and then to keep it stationary by a proper adjustment of diet, rest, and exercise. *Overfeeding is as undesirable* as underfeeding; dyspepsia and vomiting are the only results in the long run. Both have to be treated by a reduction in diet, and any superfluous weight is then so quickly lost that it cannot be taken into account in the patient's balance of loss and gain." *

Weighing of a patient's food unnecessary.—Except for scientific investigation the weighing of a patient's food is both unnecessary and undesirable, but scrupulous care in the niceties of serving and the daintiness of table appointments is essential, and will amply repay any amount of trouble.

The open-air life now prescribed for phthisical persons is conducive to appetite, and usually produces a very marked improvement in this respect.

Dainties suggested by anxious friends, and "oddments" between meals, are a great mistake. The patient's digestive organs require rest between their periods of activity if they are to perform their functions efficiently. Upon this the chance of ultimate recovery very largely depends.

The staple articles of diet will consist chiefly of milk (3 to 4 pints *per diem*), butter, bread, beef, and mutton (preferably English), milk

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* "The Dieting of Patients," by H. T., in *The British Journal of Nursing.*

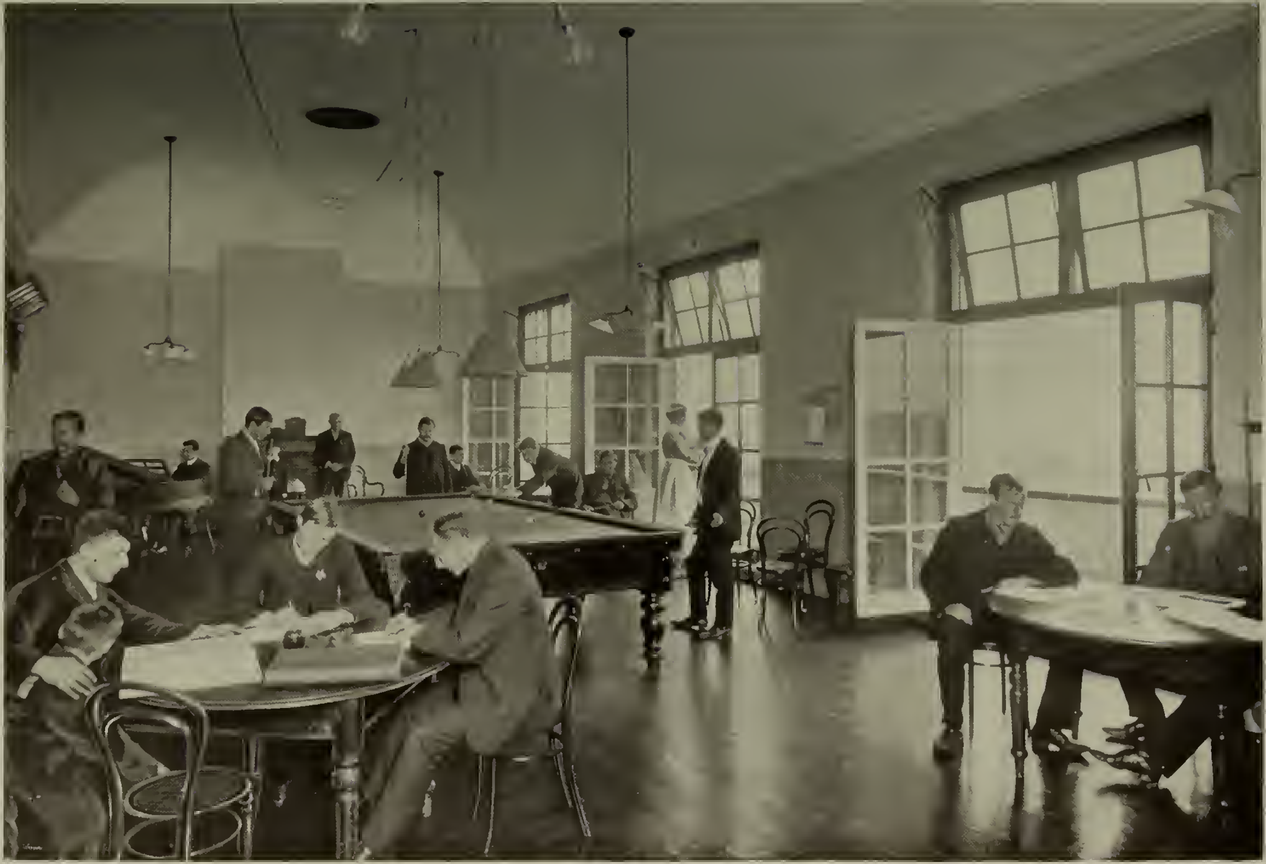

Photo: Pictorial Agency.

PLATE XXXV.—PATIENTS' RECREATION ROOM AT THE MOUNT VERNON HOSPITAL FOR CONSUMPTION, NORTHWOOD

puddings, porridge, and bacon. Great care should be exercised to avoid monotony, and to select the best possible articles of food. The milk should be sterilised (heated to a temperature of 190° F., which must be maintained for fifteen minutes, and the milk then quickly cooled), unless its origin and handling have been above suspicion. Most persons, too, can digest warm milk better than cold. All meat should be thoroughly well cooked to ensure its sterility.

No doubt English beef and mutton at their best are superior to foreign meat, but for financial reasons the latter is commonly used in public sanatoria, and the patients have not been found to suffer. Foreign pork, however, should not be allowed. Good English or Irish bacon is far preferable, and is a most useful article of food.

Specimen dietary table.—The following dietary table is in use at the Royal National Sanatorium, Bournemouth, and I am indebted to the Secretary of that institution for permission to reproduce it :—

HOURS.	DIET.
7.30 A.M.	Hot milk, ½ pint.
Breakfast, 8.30 A.M. ..	Tea, cocoa, hot milk, porridge, bread and butter, and one of the following dishes : Sausages, fried bacon, ham, cold boiled bacon, eggs, meat, kippers, bloaters, stewed kidney.
10.30 A.M.	Hot milk, ½ to 1 pint.
Dinner, 12.30 P.M. ..	Roast and boiled joints of beef and mutton, stews and curries of fresh meat, beefsteak puddings, rabbits, boiled and fried fish. Potatoes. Other vegetables in addition three times a week, according to season. Rice, sago, tapioca, macaroni, suet, currant, ginger, fruit, treacle, and plum puddings, jam rolls, fruit and jam tarts. Hot milk, ½ to 1 pint. Patients have always a choice of two different kinds of meat, and usually of pudding.
3 P.M.	Hot milk, ½ to 1 pint.
Tea, 5 P.M.	Tea, cocoa, hot milk, brown or white bread and butter, and one of the following dishes : Tripe, ham, cold meat, beef rissoles, eggs, jam, marmalade, cakes, jam tarts, stewed fruit.
Supper, 7.45 P.M. ..	Hot milk, ½ to 1 pint, bread and butter ; and either porridge, milk puddings, or soup.

During the night those patients who may be awake have hot milk brought to them by the night nurse at midnight and at 3.30 a.m.

Stimulants and special diets of poultry, etc., are provided when ordered for individual cases by the doctors.

Milk.—Many patients object at first to drinking milk in half-pint quantities, on the ground that it will curdle in the stomach and disagree with them. Sipping it with a teaspoon or nibbling a biscuit between each sip will frequently obviate this. Some patients can take hot milk better if it be slightly diluted with hot water or barley water, and cold milk if diluted with soda water. Yet another very successful plan is to add to each half-pint of milk "two tablespoonfuls of hot water in which about six grains of bicarbonate of soda and five grains of common salt are dissolved." *

Sometimes during a prolonged course of treatment a patient will complain of a feeling of biliousness. Knocking off the milk for twenty-four hours and giving half-a-pint of hot water in its place at each of the "milk times" will generally work a speedy cure.

Morning vomiting.—Many phthisical patients are troubled by a form of vomiting, generally in the morning, but in some cases immediately after any meal. Breakfast in bed may prevent this, and absolute rest before and after taking food will often prove beneficial.

Constipation.—The large quantities of milk taken, and the restricted exercise, frequently cause a very tiresome constipation of the bowels. To counteract this condition the patient should have plenty of brown bread, porridge, marmalade, fruit, and green vegetables. Massage of the abdomen is most useful in obstinate cases.

Dislike of fatty foods.—One of the difficulties in feeding consumptives lies in their general dislike of fatty foods. Butter is particularly good, but often objected to, and the nurse must exercise her ingenuity in persuading her patient to take plenty of cream and other fatty foods in a disguised form.

Diet if fever is present.—The fever of phthisis, unless very high and long continued, does not, as a rule, interfere with digestion, and patients with an evening temperature of 100° F. to 101° F., when living under open-air conditions, take and enjoy large quantities of solid food, although their weight rarely increases. Such patients should not be urged to eat enormous meals against their inclination, but if the temperature remains high and the appetite fails, a lighter diet of eggs, milk puddings, and semi-solids will be found better in the long run than any forced feeding, which can only produce nausea.

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* Dr. Burney Yeo, "Food in Health and Disease."

Intestinal tuberculosis.—The intestinal tract is frequently involved in the later stages of consumption, and a chronic and troublesome form of diarrhœa ensues, rendering the management of the dietary most difficult. In acute cases the nourishment should take much the same form as that given to typhoid patients in the early convalescent stage. Milk (in various forms), combined with arrowroot, rice, cornflour, etc., is the staple article. Eggs may be swallowed raw, very lightly poached, or beaten up. Tea and coffee must be made entirely of milk, and very weak, and not given hot. Beef tea and beef essences are forbidden.

In milder cases fish, sweetbreads, sponge and other plain cakes, and bread and butter are allowed; but meat, vegetables, and fruit are tabooed.

A patient with any tendency to diarrhœa should never take cod-liver oil.

Pleurisy with effusion.—The complication of pleurisy with effusion generally means a limiting of the fluids allowed to ℥xxx in twenty-four hours. This should be given in ℥v quantities at regular intervals; otherwise the usual light diet of chicken, fish, etc., is given.

Dry pleurisy.—Dry pleurisy, unaccompanied by fever, does not call for a change of diet, but if this complication be present, fish, chicken, milk puddings, etc., should be substituted for heavier forms of food.

Bronchitis.—Bronchitis is sometimes a very troublesome complication. It may be of somewhat chronic character, and greatly aggravated by an inappropriate diet. A patient suffering from such a combination should avoid articles of food likely to cause fermentation, and so dilatation of the stomach, which, pressing upon the diaphragm, may embarrass the heart's action. The principal meal should be taken in the middle of the day. Strong beef tea and good soups are to be recommended; and the patient should have as much milk between meals as he can conveniently take. Aërated water should not be given with milk; if a diluent is required, barley water may be employed, or alone and flavoured with lemon it will make a pleasant drink.

Acute bronchitis.—Acute bronchitis must be treated as an acute fever from a dietary point of view, and semi-solids such as arrowroot, plasmon, etc., and beaten-up eggs, or fluids only, are prescribed, according to the severity of the attack. Albumin water (made by beating up the white of an egg, slowly adding ℥v of cold water, and then straining) is most useful in very acute bronchitis.

Asthma.—The dieting of consumptive asthmatics should follow much the same lines as those laid down for the complication of bronchitis, *i.e.* the heavy meal in the middle of the day and avoidance of indigestible substances. To this we may add a restriction of saccharine and farinaceous articles. A cup of coffee during an attack of asthma is often of great service.

TEMPERATURE AND PULSE-TAKING

The state of a patient's temperature is a valuable index to the activity of the disease, and also to the amount of exercise which he can be allowed. It is usual to take the record at least twice a day, about 7 a.m., before the patient rises in the morning, and between 5 p.m. and 6 p.m. Many physicians require it also midway between the two.

Typical temperature.—A typical phthisical chart will show a temperature of the intermittent type, a rise of about two degrees in the evening and a corresponding remission in the morning, the figures varying from 97° F. to 99° F., or a little higher as the disease progresses. If an acute phase occurs the thermometer will show more fever, and evening temperatures of 102° F. to 103° F. are not uncommon; in the later stages there may be little or no morning remission.

Possible significance of sudden rise.—In a case of pulmonary tuberculosis a period of quiescence is often followed by a fresh outbreak of active disease, and one of the first signs of this is a sudden rise of temperature. It is therefore necessary in private work, where the medical man in charge of the case is not in frequent attendance, for the nurse at once to inform him of any sudden alteration in her patient's usual temperature. Whilst remembering that it is her duty to *report* such a symptom, and not to attempt diagnosis or alteration of treatment, she would be justified in keeping her patient completely at rest (knocking off all forms of exercise) until the doctor's next visit.

If the temperature should rise as high as 101° F. the nurse should take it every four hours, and record the pulse rate on the chart at the same time.

A rise of temperature is very frequently observed after an attack of hæmoptysis, especially if, as is so often the case, the patient suffers a good deal from fright and nervous shock.

A suddenly increased and maintained high temperature may be the precursor of meningitis.

Thermometric scales.—In English public sanatoria the Fahrenheit thermometric scale is almost invariably employed, but abroad the Centigrade system is in use, as it is also in private sanatoria in England where observations are being made and statistics compiled for comparing results with those obtained by foreign scientists. In such an institution the nurse will find herself expected to be conversant with the Centigrade scale, and the method of converting the one scale into the other.

Method of taking temperature.—In foreign sanatoria and those English (private) ones which are modelled closely on Continental lines, patients are instructed to chart their own temperatures, taking them in the rectum. In private work and in charitable institutions temperatures are taken in the mouth, and this is the method which the nurse should adopt unless otherwise directed. Temperatures taken in the rectum are said to be more accurate and reliable than those taken in the mouth. The thermometer in the former position as a rule registers about half a degree higher than in the mouth, and one degree higher than in the axilla. The last method (under the arm) is the least satisfactory of the three, and should not be employed unless expressly directed.

Rectal temperature-taking is, however, most unsuitable for ward work, and manifestly inconvenient for patients unless in bed and occupying single rooms.

Effect of exercise on temperature. — Dr. Burton Fanning and Dr. Champion have proved by experiment that a "physiological rise of temperature" is produced by exercise in healthy subjects as well as in persons suffering from tubercular disease, but in the latter "the reaction is usually more marked, and the rise is slightly more sustained." According to Dr. Burton Fanning* the "reaction of the temperature to exercise cannot be observed by placing the thermometer in the mouth. Exercise entails more rapid breathing, and the mouth is meanwhile held open. Its interior is, therefore, cooled by the passage of air, and perhaps by radiation and conduction also." The rise of temperature due to exercise "is only transitory, and may be missed, perhaps, if the mouth is used for its observation. . . . Example, a healthy man rests and finds that his temperature is—rectal 98.8° F., mouth 98.3° F. After half-an-hour's bicycling the temperature is again taken, and found to be—rectal 100.4°, mouth 98.4°. Replacement of the thermometer in the mouth is followed by a further rise . . . . at the end of half-an-hour 99° is registered, the rectal temperature . . . . then reads 99.5°."

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* "The Open Air Treatment of Pulmonary Tuberculosis."

Proper method of taking an oral temperature.—Dr. Burton Fanning lays great stress on the fact that "the contact of cold air with the cheeks is capable of powerfully depressing the oral temperature," a point which explains the extraordinarily low temperatures so frequently recorded by careless probationers in sanatoria on a cold winter's morning. He further states that his experience shows that "it may be necessary to keep the mouth firmly closed for half-an-hour to obviate the depressing effect of the inspiration of cold air on the oral temperature." He considers that "under ordinary circumstances ten minutes are occupied in warming the buccal cavity, during which time the lips must be kept continually closed" . . . . and that even then "less than seven minutes rarely suffice to register the maximum oral temperature."

It should scarcely be necessary to caution a nurse, in addition, against taking an oral temperature directly after a patient has been smoking or having either a warm or a cold drink. Half-an-hour must elapse after any of these actions before the mouth will be in a fit condition for the thermometer. She must also see that the patient is at rest, preferably in a recumbent position, and that there is no conversation during temperature-taking.

Danger of passing thermometer from one patient to another.—If the nurse realises that sputum is the chief source of tubercular infection she will understand how little short of criminal it is to pass a thermometer, with a merely perfunctory dip in a bowl of lotion, and a hasty dab on a towel, from the mouth of one phthisical person to that of another. Either each patient should have his own instrument or a sufficient quantity should be supplied to permit of their being properly disinfected between each case.

The pulse.—As a routine matter it is advisable for the nurse to count her patient's pulse night and morning when she takes his temperature. She will, of course, expect to find it vary in frequency in proportion to the reading of the thermometer, and she ought to know what to look for in this respect. She should allow (as for other fevers) ten additional beats per minute for each degree of fever. Should this be exceeded she ought to call the doctor's attention to the increase.

HÆMORRHAGE FROM THE LUNGS

Hæmorrhage from the lungs, or hæmoptysis, is distinguishable from hæmatemesis (bleeding from the stomach) by the frothy appearance, owing to the admixture of air, and by its bright-red colour. That coughed up later is much darker, and the clots become gradually smaller and blacker the longer the time since the blood escaped from the vessel into the air spaces and passages.

Hæmoptysis generally occurs after some exertion, such as a fit of coughing. It may be so severe that the patient dies in a few seconds from asphyxia, the upper part of his respiratory tract being completely filled with blood and clot, or it may be so slight as only to stain the expectoration, as in the "rusty sputum" of pneumonia.

When undertaking the nursing of a case of phthisis it is always wise to ascertain what the physician would wish should any hæmoptysis occur. An attack may come on suddenly at any stage of the disease, and although in a very severe hæmorrhage nothing can possibly save the patient, yet in the great majority of instances his life will depend upon the promptitude of the nurse's action.

Drugs.—The drug most commonly prescribed for such a condition is morphia. Nitrite of amyl has also been of late extensively employed. The former is given hypodermically in one-sixth or quarter grain quantities, and the latter by inhalation, 3 minims at a time. Amyl nitrite is put up in small glass capsules, each containing a dose, wrapped in a little piece of wool. The nurse crushes the capsule between her finger and thumb and holds it under her patient's nose so that he inhales the vapour without effort. The effect is generally instantaneous, but not always lasting. Still, it usually checks the bleeding until morphia can take effect.

In very slight cases the inhalation of turpentine on a piece of wool is sometimes useful.

After all hæmorrhage has ceased, many physicians give chloride of calcium, usually in the tabloid form, with the idea of increasing the coagulability of the blood.

Emergency tray.—In a sanatorium it is customary to keep an emergency tray at hand for a sudden hæmoptysis, and it is part of the

Sister's duty to see that it is always in readiness. Such a tray contains a hypodermic syringe and needles, morphia, either in tabloids or in solution, a case containing capsules of nitrite of amyl, a couple of small bowls, a packet of wool swabs, some paper handkerchiefs, a phial of ether for hypodermic use, and a bottle of carbolic lotion, 1 in 20, for preparing the skin for puncture.

What the nurse should do.—The nurse's duty in a sudden case of hæmoptysis will of course depend upon the doctor's instructions. He may have ordered nitrite of amyl to be given immediately, as we have seen, and this will often check the hæmorrhage until the nurse can get her patient into bed and morphia can be administered, *but neither of these drugs, nor indeed any drug, must be given on the nurse's own initiative.* She should always observe the golden rule of having definite written instructions from the physician before administering drugs, whether by mouth, by inhalation, or hypodermically.

In the absence of such directions her first object will be to get her patient to bed with as little disturbance as possible (not struggling to remove such an article of clothing as a tight vest, but either leaving it until after the bleeding has ceased or ripping it up at a seam). Many textbooks instruct the nurse to see that the patient lies on the side from which the hæmorrhage is coming, but apart from a nurse's inability from lack of knowledge to make any such diagnosis, experience shows that a patient suffering from hæmoptysis can rarely lie flat in bed without inducing cough, and therefore running the risk of more hæmorrhage. He should be made as comfortable as possible, and allowed to take the position in which he feels the easiest.

While the hæmorrhage is continuing no attempts should be made to give him anything at all by mouth, and, to save the exertion of spitting, the nurse should wipe his lips when necessary with pieces of cotton wool wrung out in warm water. Each piece must, of course, be burnt immediately after use.

Ice.—Ice should *not* be given except under medical orders. That usually at hand is anything but clean; it has been obtained previously by the local fishmonger to preserve his fish, and its origin is doubtful. Another objection lies in the thirst which it creates, and as in many cases the nurse has orders to regulate strictly the amount of fluid allowed for a patient with hæmoptysis, this induced thirst causes great discomfort.

The sucking of ice, too, is very liable to cause gastric disturbance, which again is a tiresome complication.

Ice bags should not be applied to the chest walls without instructions. Many physicians object to them on account of the reaction which follows their use, and which may excite fresh hæmorrhage.

Absolute quiet.—The patient must be kept as quiet as possible, mentally as well as physically. Pains should be taken to reassure him, and he should not be left alone. The mental shock caused by even a slight attack of hæmorrhage is very great, and the majority of patients suffer far more from fright than from actual loss of blood. The nurse should see that no visitors are allowed, that the room is kept cool, that the bedclothing is light but sufficient, and that hot-water bottles are in readiness in case there be any symptoms of shock.

Diet.—If the patient be very thirsty he may be given sips of water, or milk and water, but the taking of much liquid should be discouraged until the doctor's wishes are known. Meanwhile the state of the patient's pulse and temperature should be ascertained.

The diet of a patient suffering from or very liable to attacks of hæmoptysis is always carefully prescribed. Some medical men prefer to keep their patients on slops for a time, others give solid food and as little fluid as possible. More generally a fish, chicken, and milk-pudding diet is ordered until all staining has disappeared from the sputum. All agree, however, that both food and drink must be cold, and every form of stimulant, including tea and coffee, forbidden.

The bowels should be well opened. Epsom salts or hospital mistura alba are the most suitable aperients, tending as they do to lessen the blood pressure.

The nurse must always remember that even a very slight hæmorrhage may be the precursor of a fatal attack, and it is therefore not a symptom to be regarded lightly. A patient subject to "blood spitting" should not be allowed to undergo any sudden exertion. Walking upstairs is dangerous, and so are such amusements as golf or billiards, which entail much movement of the arms.

APPLICATION OF LOCAL REMEDIES

The majority of patients suffering from pulmonary tuberculosis complain far more of a feeling of lassitude and general malaise than of localised pain, but in some cases there is a good deal of aching over the tops of the affected lung, whilst in others such complications as pleurisy occasion severe suffering.

Counter-irritants.—To alleviate such conditions the medical man may order local applications in the shape of counter-irritants. Those most likely to be prescribed are either one of the several forms of "blisters," iodine, croton, or Stokes' liniment, according to the requirements of the case. The mode of application of each preparation is different, and the nurse should be conversant with them all.

Blisters.—Cantharidine, the active principle of cantharis vesicatoria (Spanish fly), is the agent usually employed for blistering.

Of the preparations in the Pharmacopœia, either the emplastrum cantharidis, the collodium vesicans, or the liquor epispasticus will be chosen. As their names imply, the first is a plaster (self-adhesive), and the other two fluid applications intended for painting with a brush on the spot marked out. These act much more quickly than the plaster, taking only four or five hours to blister, whereas the plaster generally needs nine or ten.

The part to be treated should be well washed with soap and water, and then, if the emplastrum be ordered, a piece the exact size should be applied to the skin and covered with a little wool and a bandage. This should be just tight enough to secure the plaster without causing any pressure.

If one of the fluid forms is to be used, a ring of olive oil should first be painted round the spot. This will prevent the blistering fluid from running over too large an area. The same kind of dressing as that over the plaster is required for warmth and protection.

When the blister has risen sufficiently the nurse should snip it at the lowest point, allow the serum to drain gradually on to a piece of absorbent wool, and then apply *firmly*, by means of strapping, a dressing of boracic ointment or vaseline, spread on lint. If, however, the blister is to be kept open, some mild irritant such as salicylic ointment will instead be ordered.

A loose or carelessly-put-on dressing will rub and chafe the sore place and give rise to a good deal of unnecessary suffering.

Iodine.—The preparation of iodine generally used for painting on the skin consists of equal parts of the liquor iodi fortis and the tinctura iodi (B.P.).

When it is intended to continue the treatment for any length of time the nurse should map out the part to be painted into four sections, painting one each day in turn. By the fifth day the division first treated will be ready for a second application, and so on (Lauder Brunton).

Precautions.—Persons having a delicate skin, and who blister easily, bear iodine badly, and it is always wise, when applying it to a fresh patient, to paint the first coat lightly and watch the effect.

Neither blisters nor iodine should ever be put on the skin immediately over a bony prominence, for in such a position the rubbing of a garment would speedily produce a very painful sore.

Iodine should always be applied in the morning, otherwise the smarting, which in some instances is very great, will give the patient a restless night. If the smarting be excessive a little olive oil or vaseline smeared on the painted surface, and protected by lint, will allay the discomfort.

Iodine produces on linen a characteristic dark violet stain, which does not disappear on boiling (starch reaction). This may be removed by carbolic lotion, vinegar, or any other acid.

Stokes' liniment.—Stokes' liniment is an emulsion of turpentine, acetic acid, egg yolks, and rose water. Its application gives wonderful relief to the condition known among patients as a "tight" chest. About ʒii are rubbed into the chest, both back and front, with the bare hand of the nurse. This operation takes from fifteen to twenty minutes, and cannot be hurried.

Croton liniment.—Croton liniment is applied with a piece of lint, and *not* rubbed into the skin. It very soon produces vesication, but in a much less degree than blistering. The vesicles do not require opening, and the inflamed surface should be dressed with olive oil or a simple ointment on lint.

Strapping the chest.—When there is much pleuritic pain "strapping" the affected side of the chest tends to fix it, and so affords great relief. Two nurses are required to perform the operation efficiently.

The strips of plaster (common Lister or other strapping) should be cut 2 in. wide, and long enough to reach from a point about 2 in. beyond the patient's spine on the sound side, round the painful chest wall to about 2 in. beyond the sternum. A strip should have its surface prepared by being lightly rubbed over with a swab dipped in turpentine, or by being curled backwards round a tin or can containing boiling water. It should then be stretched, the nurses pulling at each end one against the other, and the ends being doubled over to afford a holding place. The patient should now be instructed to empty his chest of air, and one nurse should apply the end of the strip over the spine, holding it firmly in position, whilst the other, keeping the strapping well on the stretch, carries it round the painful side of the chest to well beyond the breastbone. The first nurse must keep the strapping in place until the second strip is ready for use. This should overlap the first for about an inch.

The lowest strip should be put on first, the nurse working from below upwards. Eight or ten pieces may be required, and a rather wider strip should cover the ends vertically in front (and a similar piece at the back), to hold them in position, and give a neat and finished appearance to the whole. If skilfully applied the strapping will not "give" at all when the patient coughs.

PRECAUTIONS AGAINST BED-SORES

The last stages of phthisis are commonly associated with extreme emaciation, heart complications, and an impeded circulation, and those patients in whom the disease is very advanced can only rest comfortably in one position, generally sitting almost upright supported by a bed-rest or pillows. These conditions all combine to create bed-sores, or rather pressure sores, unless the nurse exercises the utmost vigilance.

When once the skin is broken the "sore" will rapidly extend. It rarely heals, and it gives rise to great discomfort.

The usual precautions of frequent washings and applications of spirit and starch powder are the best methods of prevention, and coupled with a water bed and an air cushion they ought to be successful.

WASHING OF THE PATIENT'S CLOTHES

The patient's clothes should not be washed with those belonging to the other members of the family. All flannels should be disinfected with formalin if practicable, and all cotton clothing well boiled and as little handled by the laundress as possible.

∴ The writer of this chapter is much indebted to Dr. Harsant, of Bournemouth, for many valuable hints, and for kindly reading the proofs.

CHAPTER XXI

THE NURSING OF CHEST AFFECTIONS OTHER THAN PHTHISIS

By Eleanor C. Barton

Pneumonia—Bronchitis—Broncho-Pneumonia—Pleurisy.

The nursing of chest diseases generally is a great test of a nurse's capabilities. The patients in these cases often suffer from varying degrees of dyspnœa—that is, difficulty of breathing—and it taxes all the nurse's skill and ingenuity to make them as comfortable as the circumstances allow. There is also very special need for intelligent watchfulness in order to notice every variation in the condition, and to record every change.

PNEUMONIA

By pneumonia is meant an inflammation of the lung tissue. The air cells, instead of containing air only, become filled up with inflammatory products, in consequence of which one lobe or the whole lung, or even both lungs, either together or in succession (double pneumonia), may become solid. The base only of the lung may be affected, or there may be inflammation of the apex. The latter is perhaps more often met with in children and in drunkards. Pneumonia is most common in adults. In young and healthy subjects it generally ends favourably, but in elderly people—those over the age of sixty—it is one of the commonest causes of death. In patients who are suffering from exposure or under-feeding or alcoholism, the result also is likely to be unfavourable. The form of the disease known as hypostatic pneumonia means that the bases of both lungs become consolidated, due to lying too long in one position when the circulation is weak; hence it is so often found in old people who are obliged to stay in bed after operation, or after injuries such as fractures, etc.

Symptoms.—*Pain*, usually in the affected side of the chest, but instead it may be "referred" to the corresponding side of the abdomen.

Fever, which is often ushered in by an attack of shivering; the patient's temperature may at once reach 104° or 105°.

Cough, which is short and restrained owing to the pain associated with it.

Expectoration, usually of a rusty appearance due to blood. It is very viscid, and often the sputum cup may be inverted without the contents coming out.

The *breathing* is rapid; it is also shallow, because of the pain caused by deep breathing.

In favourable cases the acute stage of the illness ends with a crisis in which the temperature falls rapidly to normal, the pulse and respiration resume their ordinary rate, and convalescence is established.

Nursing points.—The great danger to be guarded against during this illness is heart failure. Therefore the patient must be kept as quiet as possible in a recumbent position. Any sudden exertion or excitement should be discouraged. The nurse should try to anticipate all his wants so as to secure for him as far as lies in her power absolute rest, both of mind and body.

The room, if possible, should have a sunny aspect, and be kept well ventilated. The patient should be lightly but warmly covered. A pneumonia jacket is sometimes ordered. This can be made with a sheet of cotton wool inclosed in gauze, soft muslin or linen. It should be shaped so as to reach from the neck to the waist, and is secured down one side with tapes.

The food should be light and nourishing, and given at frequent intervals. It is most important that the patient should be persuaded to take a sufficient quantity, so the nurse must spare no pains to bring it to him in as tempting a form as possible. It should be given by means of a feeding cup or spoon so as to prevent any exertion.

The pain is often treated by an ice bag or poultices to the affected side, according to the doctor's instructions.

The temperature should be charted every four hours. It usually remains more or less constant at a high level till the crisis, which occurs from the third to the tenth day. The fever is often accompanied by delirium, which may be violent, especially in alcoholic patients, so that constant watchfulness is needed on the part of the nurse to prevent them from doing themselves injury. In cases of high temperature, the patient may be ordered to be sponged; directions would be given as to the temperature of the water. He should be placed between blankets and his temperature taken both before and after the sponging.

The mouth is apt to get dry and parched, and should be cleansed at frequent intervals.

Careful note should be kept of the quantity as well as the colour of the sputum.

The pulse and respiration should be charted with the temperature. Special care is required at the crisis, as the patient may become collapsed, in which case the nurse should have in readiness warm blankets, hot bottles and stimulants. With the sudden fall of temperature there is often profuse sweating, and sometimes a sharp attack of diarrhœa. Should the pulse show any sign of failure or the patient's colour become bad, the doctor should at once be sent for, as prompt treatment may be necessary.

Inhalations of oxygen are frequently ordered; these are generally given with the tube and funnel supplied with the gas.

Nurses can often do much to ward off the condition known as hypostatic pneumonia, by as far as possible gently turning the patient from side to side and supporting him in a favourable position with pillows.

BRONCHITIS

This is an inflammation of the lining membrane of the bronchial tubes, which becomes swollen, and this swelling, combined with the secretion that is poured out, blocks the tubes and makes the entry of air more difficult.

Bronchitis occurs at all ages, and is particularly fatal in old people, also in young children, especially those who are suffering from rickets. It may be acute or chronic. In the acute cases there is a definite attack, which may either clear up, or, by rendering the patient more susceptible to future attacks, may at length become chronic. Bronchitis is often brought on by exposure to cold and damp, but is also found associated with other diseases, such as Bright's disease and heart disease.

The special danger is the extension of the inflammation to the smaller tubes, and thence to the air cells of the lungs (broncho-pneumonia). In susceptible people a common cold in the head or throat may be followed by bronchitis.

Symptoms of acute bronchitis.—The onset is generally gradual. The patient may complain of a feeling of tightness and oppression, especially in the neighbourhood of the breastbone.

Fever is generally moderate, the temperature being about 101°.

Pulse and *respiration* are usually quickened, corresponding to the temperature.

The *cough* is generally accompanied by marked wheezing.

The *expectoration* is at first scanty and hard to bring up, but later becomes more abundant and frothy, and of a yellowish tint.

The course of the illness is indefinite, but under good conditions is usually favourable. As children do not expectorate, the wheezing and difficulty of breathing may be more marked.

In convalescence the temperature becomes normal, and the cough looser and less distressing.

Symptoms of chronic bronchitis.—The *temperature* in these chronic cases, unless an acute attack is superadded, is generally normal.

Respiration is usually somewhat hurried. There may be definite attacks of dyspnœa, especially on exertion.

The *pulse* is quickened in those cases where the heart is already failing under the strain.

The *cough* is generally troublesome, especially at night or in the early morning, and is usually accompanied by a large amount of frothy, yellowish-green expectoration.

Often the complexion of the patient has a somewhat bluish tint, especially after a severe attack of coughing, and in advanced cases.

Chronic bronchitis is more common in older people than in the young, and sometimes is a sequel to acute attacks. It is commonly known as "winter cough" among out-patients, as the attacks occur with great regularity during the cold, wet, winter months; later it persists also in the summer. The chief danger in chronic bronchitis is the degenerative change brought about in the lungs by the constant and often violent cough, and the strain on the heart, especially on the right side of it. This, particularly in elderly people, sometimes causes sudden death.

Nursing points.—In acute cases the patient should, if possible, be nursed in a sunny, well-ventilated room, the temperature of which should be kept constantly not lower than 60°. A steam kettle in the room helps to moisten the air and make it less irritating to the tubes. Steam tents are often ordered; these can be made by screens placed round

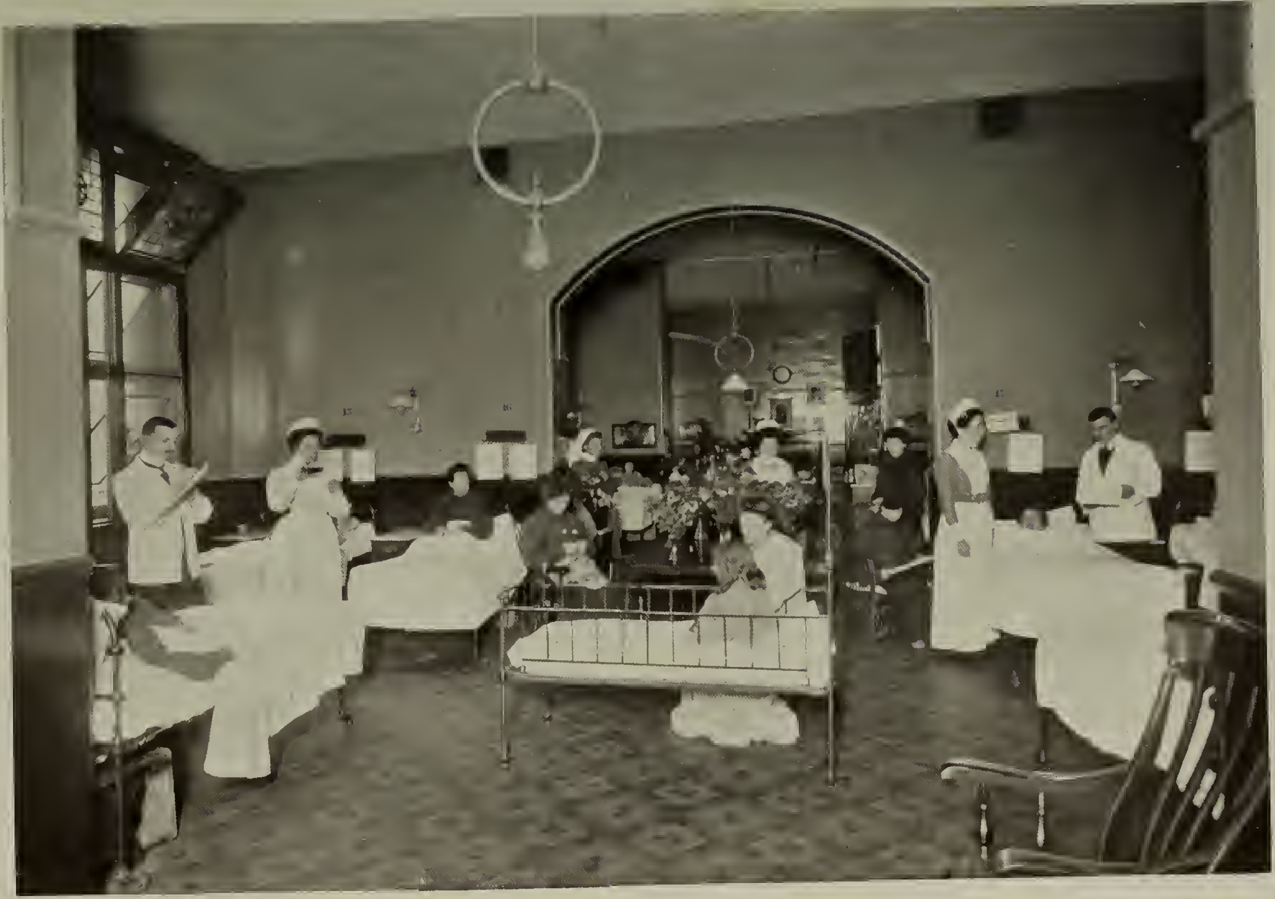

Photo: Pictorial Agency.

PLATE XXXVI.—WOMEN'S WARD IN THE ROYAL HOSPITAL FOR DISEASES OF THE CHEST, CITY ROAD, LONDON.

the bed and covered in at the top and sides by sheets, into which the steam plays directly. Tents of this kind are particularly useful for children, but their disadvantage is that the air in them is very apt to become foul and also to reach a higher temperature than is desirable. Inhalations are in many cases found very beneficial. Poultices frequently give relief, but they are often ordered not to be put on the front of the chest of young children, as they would further hamper their already distressed breathing. The diet should be light and nutritious.

Careful watch should be kept on the colour of the patient, and any blueness or lividity immediately reported. Where there is marked dyspnœa much can be done to make him comfortable by propping him up into a sitting posture, either by means of a bed-rest or by pillows carefully arranged. Sometimes relief is gained by sitting with the feet hanging over the edge of the bed, but this should only be done with the doctor's permission.

In *chronic cases* where the patients are not confined to bed there is not much to be done in the way of nursing. Care should be taken that they have no heavy meals, especially at night, and are kept in well-ventilated rooms and not exposed to wind or fogs. In very foggy weather it is advisable to fasten a piece of flannel or fine muslin across the aperture of the open window; the air will filter through. but the solid particles will be left behind.

BRONCHO-PNEUMONIA

Broncho-pneumonia is an inflammation of the finest divisions of the bronchial tubes, and also of the air cells of the lungs in relation with these. The result is a patchy form of pneumonia not involving the whole of one lobe but scattered over both lungs. It is also known as capillary bronchitis. It occurs most commonly in children and in old people. It may follow an attack of bronchitis, of which it is one of the most serious complications. In the aged it often occurs in the course of Bright's disease or some other chronic illness. In children it sometimes follows measles, whooping cough, and some of the other infectious illnesses. Owing to the obstruction to the entry of air into the air cells of the lungs, there may be collapse of certain areas of the lung.

Symptoms.—The appearance of a *child* in broncho-pneumonia is very characteristic; it breathes very quickly with a peculiar grunting sound, the nostrils expanding in the effort of drawing in the air, In bad cases there is not much *cough*, and the child is apathetic and does not cry even when disturbed.

There is a good deal of *fever*, as a rule of a very irregular kind, the temperature varying sometimes as much as from three to five degrees between morning and evening, showing in this way a marked difference from the steady temperature of pneumonia. There is often more or less *blueness* of the face, and in bad cases the child is livid. There may be *convulsions* before death.

In favourable cases the temperature falls gradually to normal.

In *old people* the symptoms are much less marked, there may be no *fever*, there is generally much *expectoration*, often *blueness*, especially of the nose, lips and ears. There may be marked *dyspnœa*, so that the patient is unable to lie down.

Nursing points.—Patients suffering from broncho-pneumonia should be put to bed in an airy room, the temperature of which should never be allowed to fall below 60°. The nursing in these cases is very much the same as in bronchitis. The bed covering should be light and yet warm. The atmosphere of the room is often kept moist by a bronchitis kettle, or the patient may be put into a steam tent. The temperature should be taken regularly, and the pulse and respiration should also be regularly charted. The diet must be light and nourishing, and given in small quantities at frequent intervals; feeding by spoon will often be required. Stimulants may be ordered to be given at intervals of one or two hours. Poultices are often advised, and should be made light, but, as in bronchitis, are usually ordered not to be put on the front of the chest as their weight would increase the difficulty of breathing. In the case of old people the difficulty is to make them comfortable in the more or less upright position in which they like to be. This can best be effected either by a well-padded bed-rest or by several pillows piled on each other and arranged so as to support the back, shoulders, and head. The tendency to slip down in the bed can be counteracted by raising the foot of the bed on blocks, or by a long covered pillow or bolster to support the hips, kept in position by being tied at each end to the sides or head of the bed. The same result would be obtained by placing some padded firm substance at the end of the bed, so that the patient's feet can press against it.

Inhalations of oxygen are often ordered.

The nursing points special to children will be dealt with in a later chapter.

PLEURISY

Pleurisy is an inflammation of the lining membrane of the lung. It may be due to cold or exposure, or injury to the chest. It very commonly arises in the course of pulmonary tuberculosis, and sometimes occurs in acute rheumatism and in Bright's disease; it may also be a complication of pneumonia. There are two kinds—the dry pleurisy and pleurisy with effusion. In the latter, fluid is poured out between the two layers of the pleura. This fluid may be clear straw-coloured, or it may be blood-stained, or may consist of pus, an abscess having formed. This last condition is known as empyæma.

The dry variety may remain so throughout the course of the illness, or it may lead on to pleurisy with effusion. The fluid may vary very much in amount, and may be as much as four pints.

Symptoms.—*Pain* in the side of a sharp and stabbing nature, increased by breathing or coughing, or taking a deep breath.

There is a variable amount of *fever*, usually of a moderate degree; this is not an invariable symptom.

There is a short dry *cough*, repressed as much as possible because of the pain it causes the patient.

Respiration is quick and shallow; the *pulse* is quickened in proportion to the temperature.

The patient may prefer to lie on the affected side because this position limits the movement of the lung. If there is much effusion he will be unable to lie on the sound side, as that is the only lung in working order. Where there is large effusion there may be marked dyspnœa on slight exertion, and a somewhat anxious expression of the face.

In favourable cases the temperature falls after a time. Sudden death may sometimes occur, either as a result of interference with the circulation (caused by the displacement of the heart which occurs in cases of large effusion), or as a result of sudden œdema of the sound lung.

Nursing points.—For these cases a well-ventilated room should be chosen, with as much sunlight as possible. The patient lies so much in one position that the nurse must exercise her ingenuity to make him as comfortable as possible by a careful arrangement of the pillows. The skin over the bony parts of the affected side should be most carefully watched, the sheets should be kept smooth and free from crumbs and foreign bodies. Should there be any sign of redness a water bed should be used or rings made of tow or cotton-wool to take off the pressure.

The temperature must be carefully noted, as this may be an important guide in tubercular cases. The pulse and respiration should also always be charted, and any signs of increasing dyspnœa reported.

The pain in the side may be relieved by poultices, by an ice bag, or by painting with iodine, or by firmly strapping the affected side. This is done (Fig. 68) by taking a large sheet of lead or other adhesive plaster, about 18 inches square, and cutting it into strips about 3 inches wide. A strip is then warmed, and when it is quite moist, the patient having emptied his chest of air as completely as possible, it is applied to the lowest part of the chest, beginning at the spine, passing downwards towards the ribs, and ending about the middle line in front. The second strip begins just below the first, and crosses it on the way to the middle line in front. The third strip runs parallel with the first, which it overlaps about 1 inch. The fourth runs parallel with and similarly overlaps the second, and so on until the painful part of the chest has been covered. The patient must empty his chest before each strip is applied.

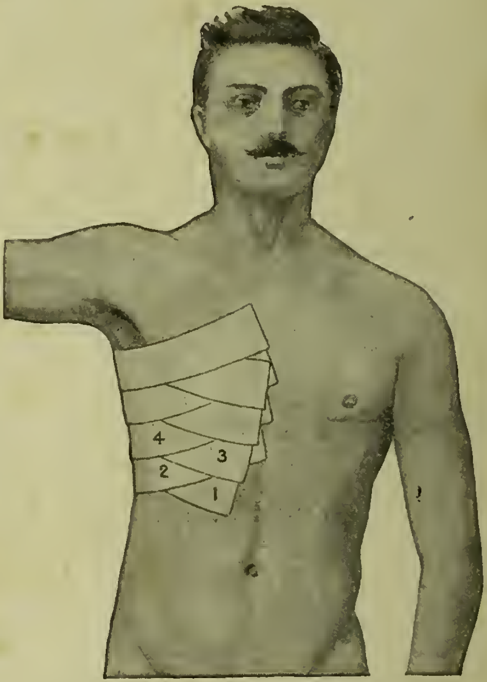

Fig. 68.—STRAPPING FOR PLEURISY.

The diet should be light and nutritious, and if there be signs of increasing effusion probably the amount of fluid will be restricted, in which case the nurse can do a good deal to relieve thirst by washing out the mouth with hot water, and cleaning it out frequently with pieces of lint or cotton-wool around her finger or around forceps. For this purpose a useful mouth-wash can easily be made with equal parts either of glycerine and lemon juice, or of glycerine and boracic acid, to which a very little hot water may be added.

In cases of large effusion the patient must be kept absolutely at rest and not allowed to make any exertion, especially any sudden exertion. He should not be permitted to get out of bed for any purpose, or even to sit up suddenly. Sometimes iodine is painted over the whole of the affected side to help in the absorption of the fluid; blisters are used for the same purpose.

In cases where tapping (paracentesis) with an aspirator has to be resorted to, the nurse will probably be required thoroughly to cleanse the part of the chest which is to be punctured, and to put on a compress. For this operation she should have ready plenty of hot water, a bowl for the fluid, a measuring glass, bowls of lotion for the surgeon's hands and for the instruments. The dressing required will be a small pad of antiseptic gauze, which is generally fixed on with collodion. Brandy or sal volatile should be at hand in case of necessity. After tapping, the patient should be kept as quiet and free from exertion as before.

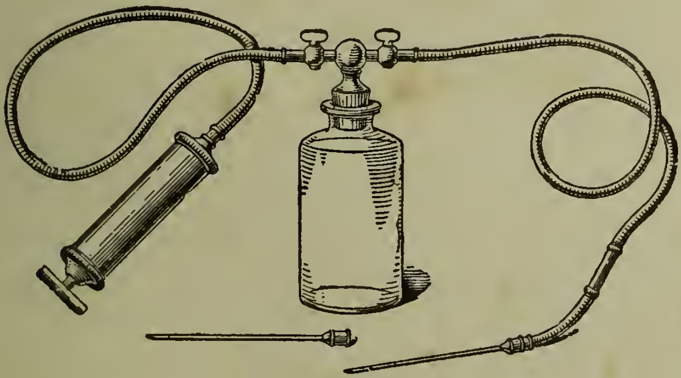

Fig. 69.—Aspirator.

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